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Pebbles
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Purple Cassius
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Quartz
Rutile
Saltpeter
Sand
Schwarz Oxyd
Selenium
Selenaite Soda
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Silex
Silver Carbonate
Smalte
Soft Soap
Soda Antimonate
Soda Ash 58%
Soda Bicarbonate
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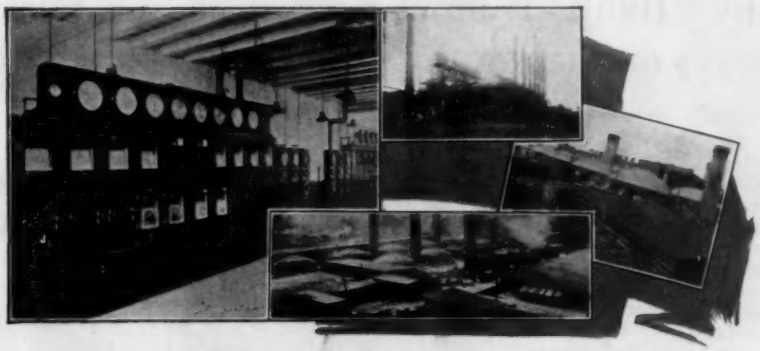

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P-58 A

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Table of Contents

SEPTEMBER, 1928

The Journal

Testing of a Red Quarry Floor Tile Kiln—Vaughan 659
The Commercial Development of a Kaolinic Fire Brick—Norton 679
Further Data on Operating Cost of a Platinum-wound Resistance Furnace—Orton and Krehbiel 685
Mineral Constituents and Origin of a Certain Kaolin Deposit Near Spokane, Washington—Goodspeed and Weymouth 687
A New Apparatus for a Rapid Sedimentation Analysis—Van Nieuwenburg and Schoutens 696
Study of China Bodies of Belleek Type—Collins 706
Suspension of Glazes and Barium Carbonate Water—Lee 713
Equations and Tables for Shrinkage, Expansion and Design Calculations—Westman 715

Ceramic Abstracts

587

The Bulletin

Editorials

What is Being Done in Ceramic Architecture in Europe—Warner 253
A Lesson in Design from the Sandhill Potters of North Carolina—Payant 256

Papers and Discussions

A Laboratory for the Technical Control of the Manufacture of Refractories—Trostel 260
Business Management—Ferguson 267
Continuous Enameling Furnace—Owen 272

Activities of the Society

Your Membership Status 277
New Members Received from July 1 to August 1 278
News from Members of the Society 278
Ceramists' Tour Abroad 279

Notes and News

Collegiate Study of Ceramic Arts 286
An International Exhibition of Ceramic Art 298
Marking of Imported Pottery 298

Calendar of Conventions 299

Advertisers' Index 29

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TESTING OF A RED QUARRY FLOOR TILE KILN[1]

By W. Harry Vaughan[2]

ABSTRACT

A practical test of a round downdraft kiln firing red quarry floor tile is given. The results showed a considerable saving in fuel and time and an increase in the quality of ware amounting to more in value than the saving in fuel. An investigation of firing conditions in the average large plant using similar kilns is recommended as an investment which will yield dividends.

Purpose

The purpose of this investigation was to determine whether or not the fuel consumption of kilns in the plant could be reduced by redesign, changes in firing methods, or changes in the firing schedule. It was hoped, at the same time, that an increase in the percentage of dark shades of red and "A" grade ware could be obtained.

Description of the Ware and Kiln

The ware fired in these tests consisted entirely of red 6- by 6- by $^3/_4$-inch corrugated back red quarry floor tile made by the stiff-mud process. These units were set face to face 64 courses high in two steps. The lower bung was 44 tile high, the stack being tied in with 20 courses at this height.

The kiln was one of the usual types of round downdraft kilns having a "T" flue system, feather flues, and floor blocks. The inside diameter of the kiln was 30 feet. The spring of the crown arch was 7 feet above the floor level. The crown was 15 inches thick, consisting of 9 inches of fire brick, $2^1/_2$ inches of Sil-O-Cel brick grouted with powder, $2^1/_2$ inches of face brick, and 1 inch of tile and waterproofing. The walls were 36 inches thick from the foundations to a height of 5 feet, where they decreased in thickness to 18 inches in one step. The wall was insulated with a $4^1/_2$-inch thickness of Sil-O-Cel brick from the foundation to the spring of the arch. There were ten fire boxes of the dead-bottom grate type having 22-inch front openings and 18-inch back openings to the bag walls. The fuel

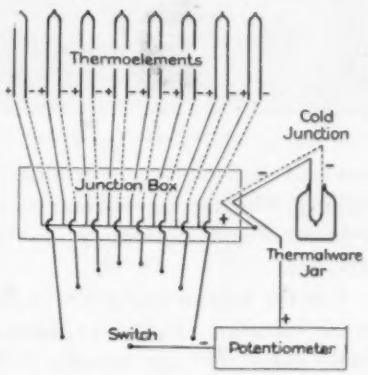

Fig. 1.—Wiring diagram.

[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February, 1928. (Heavy Clay Products Division.) Received April 25, 1928.

[2] Associate Professor of Ceramic Engineering, Georgia School of Technology, Atlanta, Ga.; Consulting Ceramist, B. Mifflin Hood Brick Co., Daisy, Tenn.

entrances to these boxes consisted of poke holes 12 inches wide and $13^1/_2$ inches high to the top of the poke-hole arch. The top of this arch was flush with the top of the firebox arch. The main flue was 34 inches wide, 26 inches high to the spring of the 6-inch arch, and 22 feet long from the center well-hole to the base of the stack. The stack was a 40-foot lined type 34 inches square inside. Approximately 100 tons of the 6- by 6- by $^3/_4$-inch tile could be set per firing.

Apparatus

The apparatus used for observing the manner in which the test kiln was being fired consisted of the usual company pyrometers; eight chromel-alumel thermo-elements connected to compensating leads, a junction box, a thermal ware jar filled with ice, copper leads to a Brown portable potentiometer (wiring diagram shown herewith, Fig. 1); cones; solution balance and weights; wires for suspending tile and racks for holding them; one static pressure draft gage and one differential pressure draft gage, the former connected with three pipes, the latter to each side of a pitot tube; a water-cooled gas sampler connected to an Orsat gas analysis set by means of pipes, tubes, and a train of bottles through which the gas bubbled and discharged as the result of the suction of a filter pump; an accurately controlled damper; aneroid barometer; hygrodeik; scales; dump carts; shovels; rubber tubing; charts; log sheets; running water; certain chemicals for the solutions and bottles to contain them; protection tubes; a clock; and ice.

FIG. 2.

For the second firing, fire boxes and bag walls were redesigned, grates were installed, and a gasoline engine driven fan with a capacity of 5000 cubic feet per minute at $1^1/_2$-inch static pressure was used with a gooseneck in the stack backdraft plate for watersmoking.

Procedure

The above apparatus was arranged so as to allow readings as follows:

Temperatures Readings were taken each half hour in the crown (both company platinum couple and experimental base metal couple), at the top of the ware in the kiln gases, in the center of a drilled 6- by 6- by $^3/_4$-inch tile next to the top course, in the fire box at the end of the combustion arch, at the bottom of the kiln just above the floor in the kiln gases, in the center of a 6- by 6- by $^3/_4$-inch

drilled tile set one course above the floor, in the well-hole of the main flue, and in the main flue at the base of the stack. Measurements for top and bottom temperatures in the kiln gases and ware were made directly under the crown pyrometer, which was located 3 feet 2 inches down the crown from the center toward the door where the junction box was located.

Hygrodeik thermometers were read each hour at the same time as the barometer, the results giving relative humidity as well as the temperature of the atmosphere.

Pressures Readings were taken every hour simultaneously with barometric pressure, temperature, humidity, and water-smoking weights. Static pressures above the kiln floor at the well-hole of the main flue, below the floor at the well-hole of the main flue, and in the main flue four feet from the base of the stack, were taken with an Ellison inclined draft gage equipped with zero adjustment. Differential pressure, that is, pressure due to gas flow in the main flue, was measured with an Ellison inclined draft gage from a point opposite the static pressure tube. Both of these gages measure negative pressure to 0.01 inch directly and, by estimation, to within 0.002 inch.

Weights Fourteen tile suspended in each of two racks, one at the top, the other at the bottom of the set ware, were weighed every hour by means of the solution balance. These weighings were made to an accuracy of three grams in fifteen thousand. Determinations were discontinued when the steel wires stretched excessively at crown temperatures between 1400° and 1500°F. Though this data is usually taken as indicating the rate of expulsion of water from the ware, it should be understood that the circulation of air around tile thus suspended is greater than the circulation of air or gas around tile regularly set and in more remote sections of the kiln. Hence, water will leave these tile at a more rapid rate than could be expected of the average ware in the kiln.

Coal was weighed by dump carts, seven to nine carts of approximately 1500 pounds each constituting the coaling of a kiln. The total number of shovels of coal per firing was entered in the kiln log. The number of shovels per firing was added and divided into the weight of a coaling to obtain the average weight per shovel of coal fired during a given period. From these figures the total amount of coal used per firing was obtained. Each coaling was kept separate and fired progressively until consumed in order to check the weight of coal per shovel and per firing at regular intervals.

Flue-gas Analysis A continuous sample of gas was taken from the main flue by means of a water-cooled gas sampler and a filter pump working through a train of bottles for collecting soot,

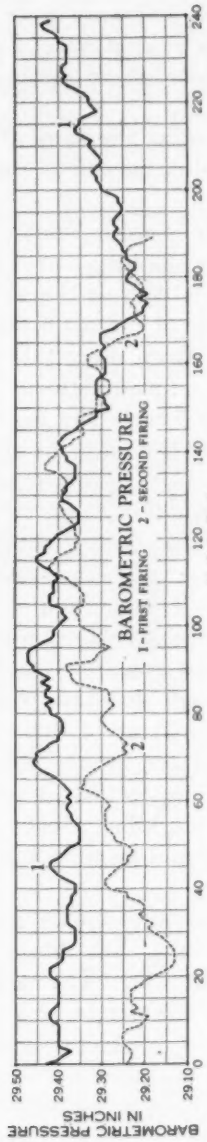
BAROMETRIC PRESSURE
1 - FIRST FIRING 2 - SECOND FIRING
HOURS
BAROMETRIC PRESSURE IN INCHES
29.50
29.40
29.30
29.20
29.10
0
20
40
60
80
100
120
140
160
180
200
220
240
1
2

FIG. 3.

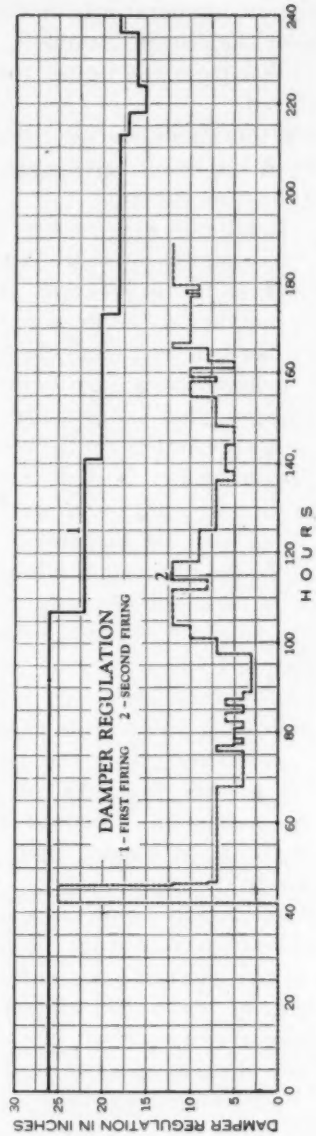
DAMPER REGULATION
1 - FIRST FIRING 2 - SECOND FIRING
HOURS
DAMPER REGULATION IN INCHES
30
25
20
15
10
5
0
20
40
60
80
100
120
140
160
180
200
220
240
1
2

FIG. 4.

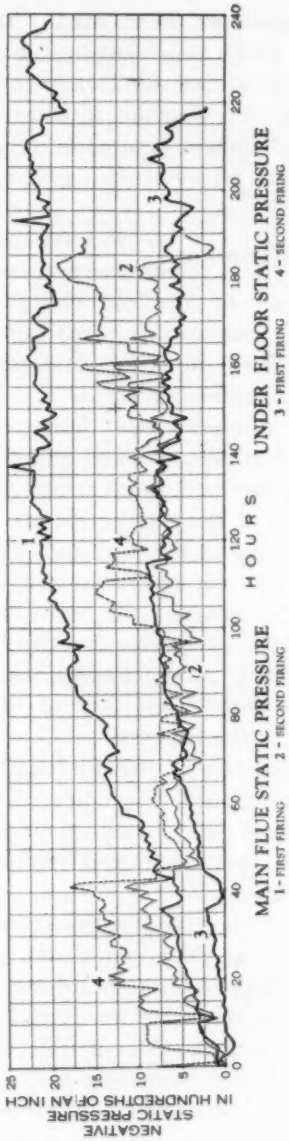
NEGATIVE
STATIC PRESSURE
IN HUNDREDTHS OF AN INCH
25
20
15
10
5
0
0
20
40
60
80
100
120
140
160
180
200
220
240
HOURS
MAIN FLUE STATIC PRESSURE
1 - FIRST FIRING
2 - SECOND FIRING
UNDER FLOOR STATIC PRESSURE
3 - FIRST FIRING
4 - SECOND FIRING
1
2
3
4

FIG. 5.

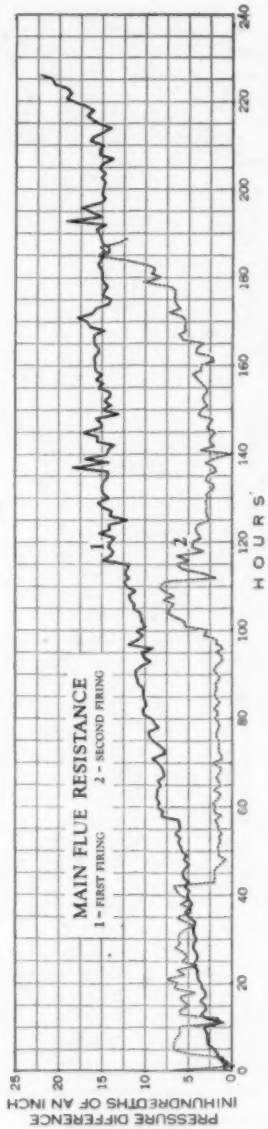
PRESSURE DIFFERENCE
IN HUNDREDTHS OF AN INCH
25
20
15
10
5
0
0
20
40
60
80
100
120
140
160
180
200
220
240
HOURS
MAIN FLUE RESISTANCE
1 - FIRST FIRING
2 - SECOND FIRING
1
2

FIG. 6.

water, etc. This sample was taken at the rate of 200 cc. per minute. The apparatus was thrown open to the 600 cc. reservoir each hour when analyses were made, and a sample taken representing the average of about five minutes in the kiln atmosphere. Carbon dioxide, oxygen, and carbon monoxide were determined, nitrogen being obtained by difference.

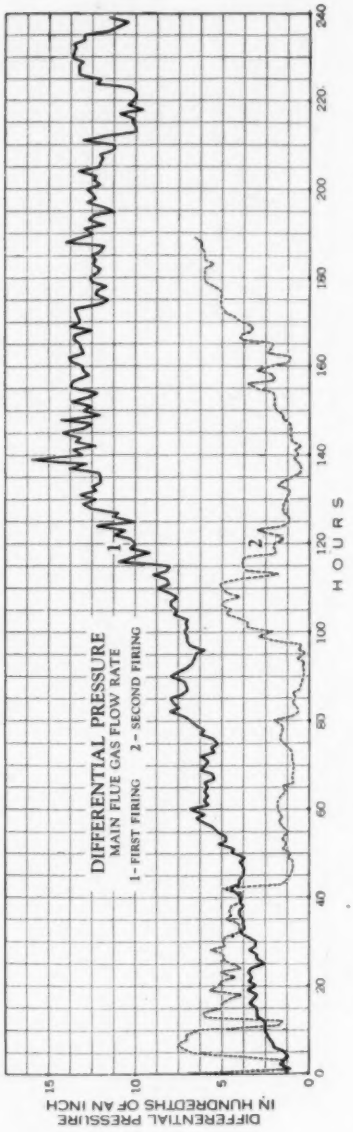

FIG. 7.

Miscellaneous Ice was renewed in the thermalware jar before all of the old charge had melted, thus insuring maintenance of the cold junction temperature within a degree or so of 32°F.

The damper was hung on a simple but accurate and quickly adjustable rod and notch arrangement. A record of the damper adjustment was entered in the kiln log.

Atmospheric conditions were noted as well as any peculiar or accidental phenomena accompanying the firing.

Judgment of the finish of the kiln was, in both cases, left to the integrity of the fireman.

Comparison of the first and test firings in regard to quality of ware, duration of firing, coal consumption, ease of operation, and regulation, was made.

All of the observations can be made by one man; three men working in shifts of eight hours each obtained the data previously indicated in this article. All of the operations and tests were simplified so that university sophomores employed by the company on summer work took care of all of the data.

Methods of Firing The regular plant fireman fired the kiln during both plant and test firings, the first firing under plant routine, the second under the direction of the ceramic engineer and the crew working with him.

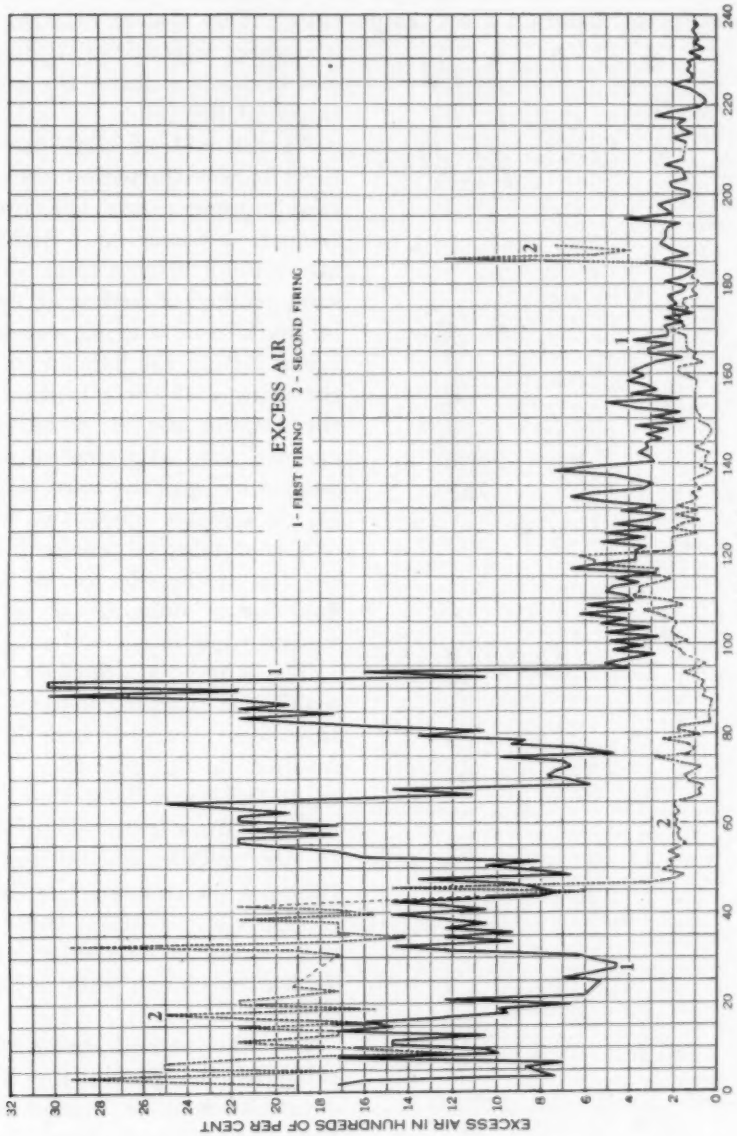
EXCESS AIR
1 - FIRST FIRING 2 - SECOND FIRING
EXCESS AIR IN HUNDREDS OF PER CENT
HOURS
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
0
20
40
60
80
100
120
140
160
180
200
220
240
1
2

FIG. 8.

The plant system of firing was to watersmoke sixty hours, coaling the entire number of eyes at once as often as the pyrometer indicated its necessity to maintain a set temperature. This system resulted in a coaling interval of 2 hours and 45 minutes during the early stages of the firing.

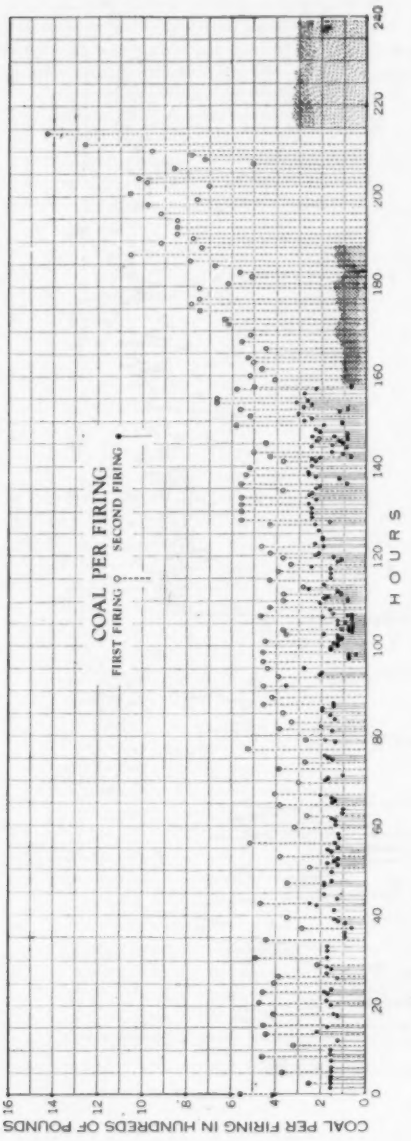

FIG. 9.

At the end of sixty hours, the kiln was started on a slight raise in temperature, the crown temperature being slightly above 400°F at that time. The same method of coaling all eyes in the kiln at a firing was followed during the remainder of the firing with the exception of the soaking period, when one eye was fired at a time to prevent smoking of the ware. During this latter stage the kiln was kept clear of smoke from the top of the tile to the kiln floor since smoking gives a flashed edge on the ware.

The kiln was finished by soaking a varying length of time after cone 4 had been reached in the top tile. The exact finish was determined by means of draw trials taken from the top, middle, and bottom of the ware on two opposite sides of the kiln. Usually cone 01 went down at the floor level during the finish with a high damper.

For the second firing the principal changes in the kiln construction were smaller fire boxes using knock-down slant grates instead of dead bottoms. Bag walls were decreased in height from 66 inches to 51 inches.

The coaling was more frequent and lighter. During the earlier stages, this was accomplished by coaling every other eye at a firing. When the

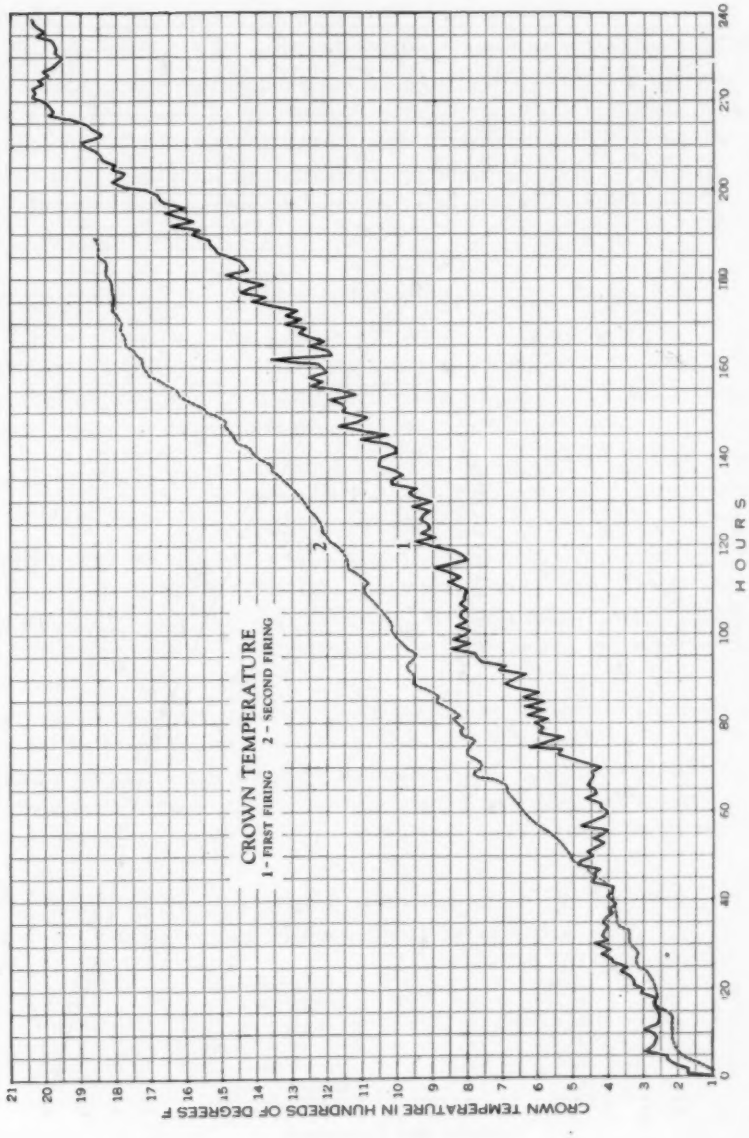
CROWN TEMPERATURE
1 - FIRST FIRING 2 - SECOND FIRING
CROWN TEMPERATURE IN HUNDREDS OF DEGREES F
HOURS
0 20 40 60 80 100 120 140 160 180 200 220 240
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

FIG. 10.

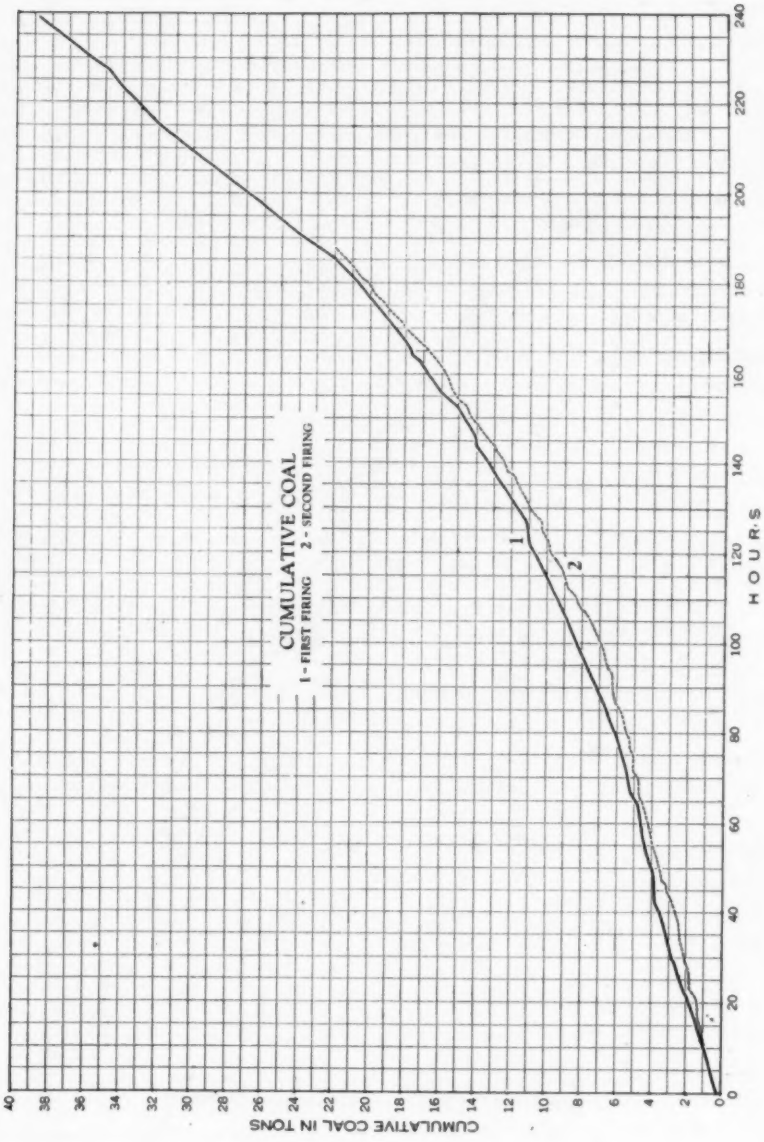
CUMULATIVE COAL
1 - FIRST FIRING 2 - SECOND FIRING
CUMULATIVE COAL IN TONS
HOURS
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
0
20
40
60
80
100
120
140
160
180
200
220
240
1
2

FIG. 11.

soaking period was reached the single-eye method of coaling was adopted. The ratio of coaling frequency during the plant and test firings was approximately 165 minutes to 75 minutes for the earlier stages.

The use of a fan for induced draft during watersmoking resulted in a 42-hour watersmoking period in place of a 60-hour watersmoking period. The total firing time was theoretically shortened 39 hours; actually this time-saving amounted to 50 hours. This was due to a faster schedule and a shortened watersmoking period. The high excess air carried at the end of the second firing probably resulted in a faster finish during soaking.

Results

The results are given here in graphical and written form. Where it has been necessary to elaborate upon the significance of a particular portion of the data, this has been enumerated in figures or tabulated so as to facilitate comparisons and conclusions.

Notes in Connection with Data

The fire boxes and bag walls, ten in number, were all built in the kiln during the two days when it was set. As it rained during this period and the mortar did not have time to dry before firing, there was considerable moisture driven into the kiln atmosphere during the early stages of the watersmoking period. This condition retarded this period of the firing, the air which came in contact with the ware having an abnormally high relative humidity and, in consequence, less moisture carrying properties. Conservatively estimated, the additional amount of coal required to drive off the moisture in the 5630 fire brick and 3000 pounds of mortar in the new fire boxes and bag walls would amount approximately to a ton. To counteract this fuel requirement, the tile set in the kiln for the second firing contained less moisture than those set for the first.

In both firings run-of-mine coal was used, the following analysis made by the Bureau of Mines being representative:

Moisture	3.20%
Volatile matter	38.50
Fixed carbon	53.30
Ash	5.00
Sulphur	1.10
B.t.u. per pound	13,980
Ash fusion point	2600°F

Since this test was of the nature of a practical test, the analysis of the ash and refuse taken from the boxes will not be given, and a heat balance of the kiln will not be attempted.

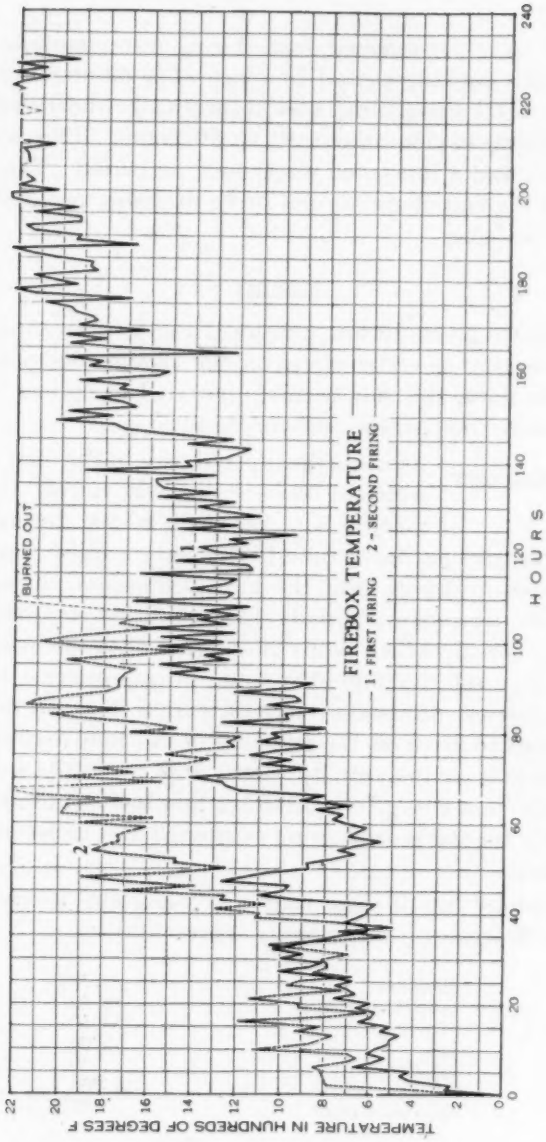
FIREBOX TEMPERATURE
1 - FIRST FIRING 2 - SECOND FIRING
BURNED OUT
TEMPERATURE IN HUNDREDS OF DEGREES F
HOURS
0
2
4
6
8
10
12
14
16
18
20
22
0
20
40
60
80
100
120
140
160
180
200
220
240

FIG. 12.

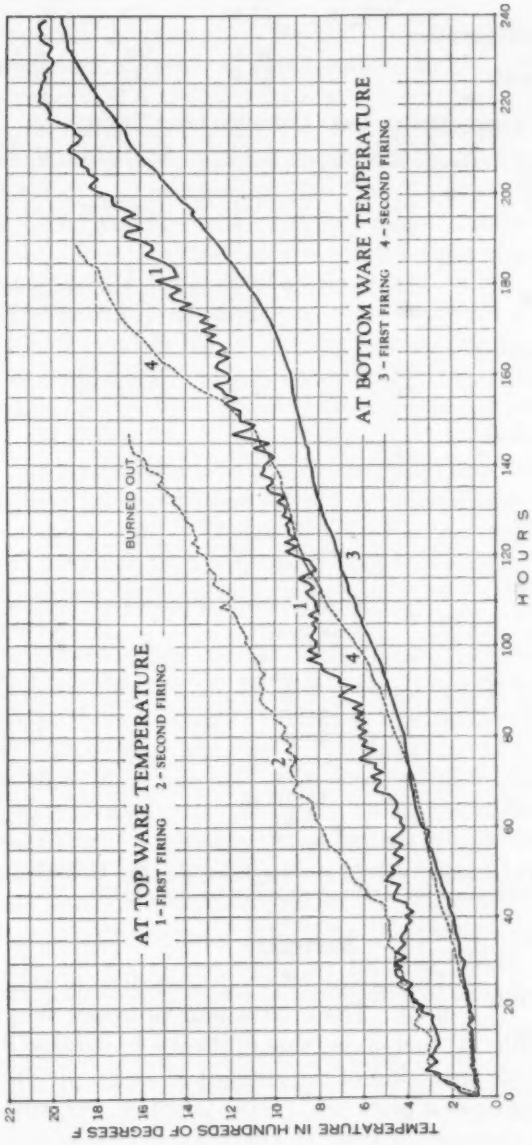
AT TOP WARE TEMPERATURE
1 – FIRST FIRING 2 – SECOND FIRING
AT BOTTOM WARE TEMPERATURE
3 – FIRST FIRING 4 – SECOND FIRING
BURNED OUT
TEMPERATURE IN HUNDREDS OF DEGREES F
HOURS
0
20
40
60
80
100
120
140
160
180
200
220
240
2
4
6
8
10
12
14
16
18
20
22

FIG. 13.

STATISTICAL COMPARISON OF THE TWO FIRINGS

	Fired weight ware (tons)	Total coal (tons)	Coal per ton ware (lbs.)	"A" grade %	Total hours
Plant	105.22	38.6	734	58.8	239
Test	103.16	22.0	426	65.1	189
Saving in test over plant firing (gross)		16.6	308	6.3	50
(in per cent)		43.0	42	10.7	20.8

FIRING PERIOD DATA OBTAINED FROM CURVES

Period (firings)	Duration (hours)	Coal fired (tons)	Water removed (%)	Crown temperature at end period (°F)
Watersmoking				
Plant	55	4.4	4.0	418
Test	36	2.4	2.2	370
Heating up				
Plant	77	7.6	Loss probably	905
Test	37	2.6	oxidation here	795
Dehydration (oxidation)				
Plant	23	3.7	2.15	1205
Test	48	4.8	2.75	1190
Heating up (oxidation)				
Plant	45	11.0		1740
Test	42	6.0		1740
Soaking				
Plant	39	11.9		2030
Test	26	6.2		1855

TEST KILN DRAWING RECORDS

Classification of Ware	Plant Firing (%)	Test Firing (%)
"A" Grade		
Shade 5	0.10	0.00
Shade 4	7.76	11.38
Shade 3	24.31	25.71
Shade 2	26.66	28.01
"B" Grade		
Dark	8.76	10.49
Light	13.27	6.40
Underfired*	2.40	6.63
Total loss	16.73	11.36

* Some of the "underfired" ware in the test firing was due to setting ware which required a higher temperature for maturity than the regular red tile.

Summary

Fuel Consumption The saving effected amounted to 43% of the fuel fired. There were four principal reasons for this satisfactory result: (1) fuel saving due to the use of induced draft during watersmoking, (2) reduction of the amount of excess air during certain stages, (3) adoption of a more rapid firing schedule, (4) reduction of the rate of gas flow through the kiln. It will be noted that at no time did the fuel consumption of the test firing exceed that of the plant firing at a corresponding hour despite the fact that the time was considerably shortened and the temperature rise was greater in the test firing.

The maximum rate of coal consumption during the plant firing was 800 pounds per hour. During the test firing this rate was 445 pounds per hour.

The average fuel consumption for ware fired to 2000°F and cone 4 heat treatment in the length of time required for the firing of these tile will vary between 450 and 550 pounds of coal per ton of ware. The fuel economy in the second or test firing was 426 pounds of coal per ton of ware. The plant has subsequently fired the kiln with greater economy without the use of a watersmoking fan. The fuel economy in this latter instance was 376 pounds of coal per ton of ware. A later firing, again using a fan, has shown a result of 347 pounds of coal per ton of ware. No sacrifice in quality of ware was experienced.

Definite and partially controlled oxidation periods were maintained at 1000 to 1250°F and at the end of the soaking period during the test firing. These were thought advisable in view of the nature of the ware, though it might be said that the plant experiences no difficulty with the oxidation of the ware.

Quality of the Firing

An examination of the curves will show how much more accurate was the regulation of temperature rise during the second firing. The two bad firing intervals on the crown temperature curve (at the 70th and 90th hours of the test) were due to the inexperience of the firemen with the grates substituted for the dead bottoms.

Due to the failure of the thermo-element in the bottom ware, a check on the temperature in this course of tile could not be obtained during the test firing. The kiln should have been held for soaking about four hours longer. This error was due, it was believed, to the use of draw trials which were too small and more exposed than the regularly set tile, for the ware was pronounced a good finish by the fireman.

Notwithstanding the amount of underfired tile in the test, the increase in value of the kiln of ware amounted to several times the saving in coal. This was due to an increase in "A" grade tile and the darker shades as well as a decrease in culls. The "A" grade tile increased from 58.8 to 65.1% or 6.3%. The total loss decreased from 16.7 to 11.4%. In the case of both firings, the drawing records of the kilns immediately preceding and immediately following the test kiln were examined in order to determine whether or not the quality of the ware was in a state of transition due to better clay from the pit, improved manufacture, or more careful firing. No data which would alter the representative quality of the tests were encountered. The percentage of "A" grade ware averages about 45% in winter and 52% in summer. Therefore, the plant firing was considered above the average and the test firing came close to a high record for the plant.

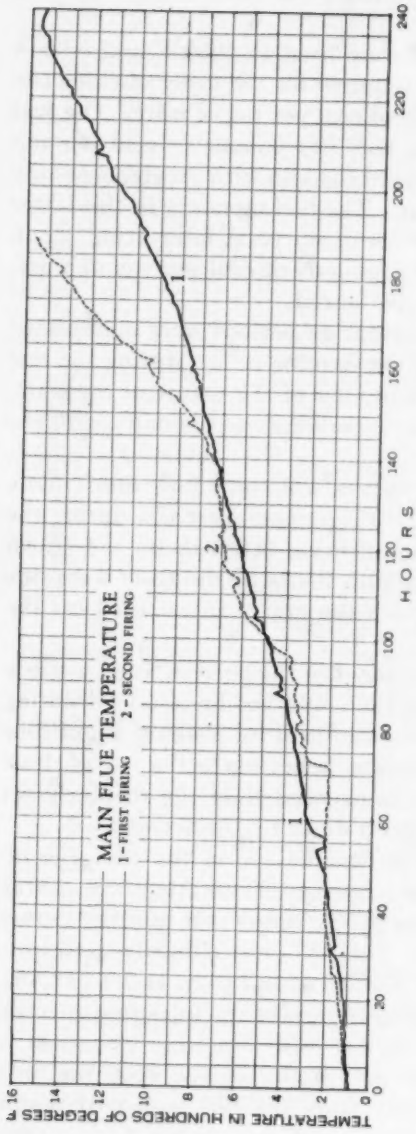
MAIN FLUE TEMPERATURE
1 - FIRST FIRING
2 - SECOND FIRING
TEMPERATURE IN HUNDREDS OF DEGREES F
HOURS
0
2
4
6
8
10
12
14
16
0
20
40
60
80
100
120
140
160
180
200
220
240
1
2

FIG. 14.

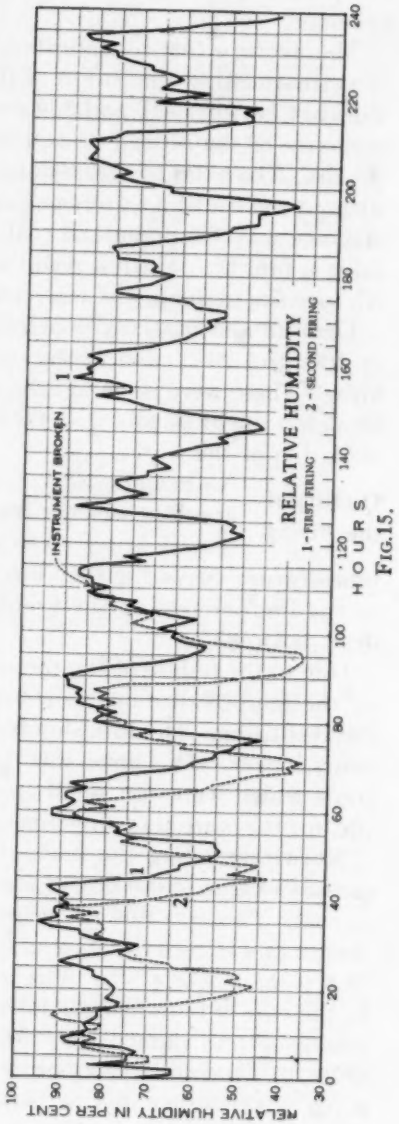
RELATIVE HUMIDITY
1 - FIRST FIRING
2 - SECOND FIRING
INSTRUMENT BROKEN
RELATIVE HUMIDITY IN PER CENT
HOURS
30
40
50
60
70
80
90
100
0
20
40
60
80
100
120
140
160
180
200
220
240
1
2

FIG. 15.

Ease of Operation The use of a direct-driven fan of 6500 cubic feet per minute capacity at $1^1/_2$ inches static pressure for watersmoking has proved very satisfactory and economical. The watersmoking time has been shortened 25% by the use of a fan.

A change in the method of damper hanging facilitated the accurate regulation of this device for draft control. It was found that a rather

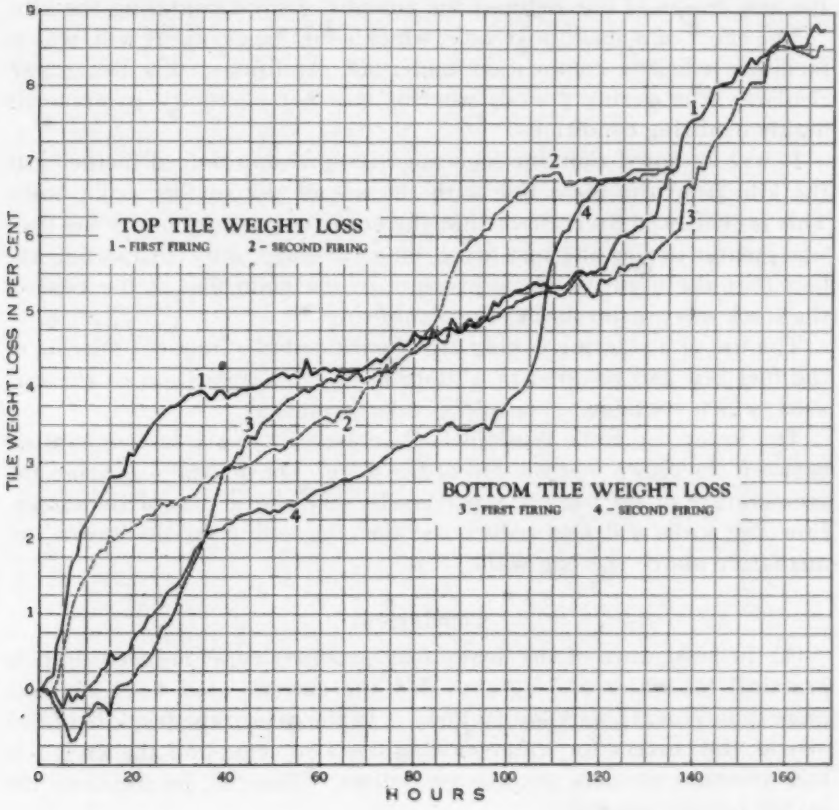

FIG. 16.

definite fuel bed thickness should be carried for a certain damper height in order to obtain efficient combustion.

The good control of excess air during the test well indicated the value of a new poke-hole design in controlling this phase of firing. In less than six hours following the completion of watersmoking, the excess air had been reduced to below 200%. There was no trouble in obtaining an oxidation near 1100°F by opening the poke holes. During this period the excess air averaged 300% over an interval of about 20 hours. For

the last four hours the excess air was increased to about 600% for the double purpose of oxidation and the finish of the bottom of the kiln.

Effect of Redesigned Fire Boxes and Bag Walls

The smaller box with grates was much hotter than the old dead bottom design. At a crown temperature of 1080°F this difference was about 300°F. During the latter stages of the test the new design of box reduced the amount of smoke entering the kiln.

The effect of a small poke hole, which could be closed at will, was to facilitate efficient combustion under all conditions, this being particularly true during periods when it was not necessary to maintain highly oxidizing conditions.

It will be noted that the high negative pressure moved farther into the kiln from the main flue with the use of the smaller poke holes. This is evidenced by the fact that the negative pressure under the floor was greater during the test firing, on an average, notwithstanding the fact that the negative static pressure in the main flue at the base of the stack was greater during the plant firing.

The use of a slanting coking arch facilitated the frequent stirring of the fuel bed and resulted in a more thorough combustion of the fuel used, which contained about 38% volatile matter.

The lower bag walls resulted in a greater difference in temperature between the crown and the top of the ware. During the test firing the temperature in the top tile was considerably above that of the crown. Low bag walls will also reduce the slagging action on the crown immediately above the bag walls.

Conclusions

(1) In most ware of the heavy clay products type, induced draft is practical for watersmoking provided the current used does not cost more than 2 cents per kilowatt hour. In the case of the test kiln of this article, the current for watersmoking costs 86 cents and the saving in fuel amounts to more than seven dollars. There is, in addition, the saving in time effected.

(2) The fuel consumption of the average kiln can be reduced by the intelligent use of the damper. Since the loss of fuel out of the stack in the form of hot kiln gases amounts to between 27 and 60% in the average kiln, it is obvious that the lower the damper at which a kiln can be fired, other factors being equal, the less the loss out of the stack will be.

(3) The use of poke holes which can be adjusted to control the percentage of excess air contributes considerably to fuel economy. The prime purpose of these two control factors in fuel combustion, the damper and the poke hole, is to vary the rate and efficiency of com-

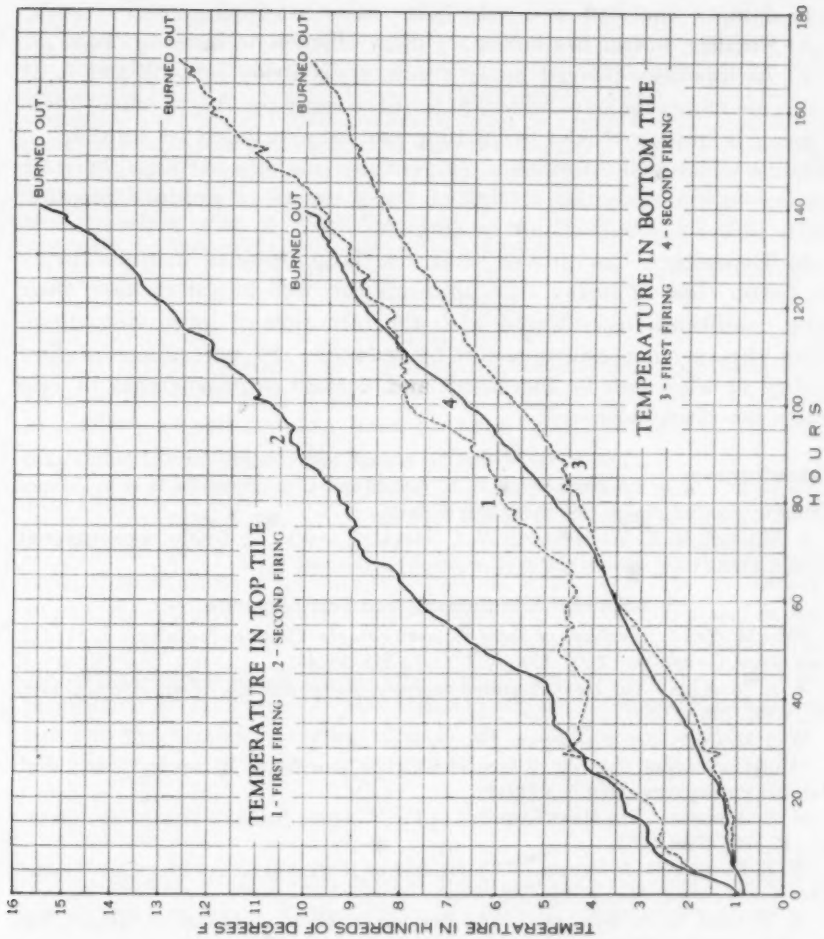
TEMPERATURE IN HUNDREDS OF DEGREES F
HOURS
TEMPERATURE IN TOP TILE
1 - FIRST FIRING 2 - SECOND FIRING
TEMPERATURE IN BOTTOM TILE
3 - FIRST FIRING 4 - SECOND FIRING
BURNED OUT
BURNED OUT
BURNED OUT
BURNED OUT
1
2
3
4

FIG. 17.

bustion. The damper may be considered a primary valve controlling the total volume of air passing through the kiln. The poke hole may be considered a secondary air valve largely controlling the efficiency of combustion by varying the percentage of excess air. By means of a few regulated test firings in a plant, accurate direction of the way to carry damper, fuel bed, and poke hole can be attained.

(4) Smaller, hotter fire boxes are more efficient in burning coal.

(5) As has been proved many times, short firing periods and light firings are more efficient and less harmful to the ware. As the smoothness of firing is improved, the firing time can be shortened to approach a schedule which will establish a temperature gradient through the ware causing such differential strains in the ware as to produce rupture. A safe slower schedule should be adopted.

(6) Experience has proved that the larger plants manufacturing the better class of heavy clay products can well afford to have their firing conditions investigated with the intention of improving them. Often the fuel consumption can be reduced, the percentage of first quality of ware can be increased, and certain improvements in kiln design are often indicated.

Acknowledgment The writer wishes to express appreciation for the helpful suggestions which R. E. Arnold and C. E. Parmelee have made concerning apparatus, design, and the taking of data.

L. Mitchell, R. E. Whittenberg, W. C. Hansard, and C. M. Griffin, sophomores at Georgia Tech., took most of the data required for this test work.

Additional Kiln Economy and Test Literature

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A. E. MacGee, "The Heat Required to Fire Ceramic Bodies," *Jour. Amer. Ceram. Soc.*, **9** [4], 206 (1926).

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W. E. Rice and R. A. Sherman, "Determination of Heat in Kilns Firing Clay Wares," *Jour. Amer. Ceram. Soc.*, **7** [10], 738 (1924).

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G. A. Bole, John Blizard, W. E. Rice, E. P. Ogden, and R. A. Sherman, "Problems in the Firing of Refractories," Bur. Mines, *Bull.*, No. 271.

J. B. Lyon, "Kiln Construction," *Jour. Amer. Ceram. Soc.*, **10** [3], 185 (1927).

Robert M. Linton, "Some Investigations on Kiln Burning," *Jour. Amer. Ceram. Soc.*, **10** [7], 493 (1927).

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THE COMMERCIAL DEVELOPMENT OF A KAOLINIC FIRE BRICK[1]

By F. H. Norton[2]

ABSTRACT

The development of a kaolinic brick from Georgia clay is described. The high and continued shrinkage of this clay makes it necessary to fire the brick at a very high temperature. A temperature of over 3000°F was required. The development of a kiln for the firing of the grog and brick was a problem that was satisfactorily solved. A light weight brick for use in marine boilers and a dense refractory for use in glass tanks were developed. The following physical properties of these two refractories are given and compared with other high grade bricks: (1) start of deformation under 25 lbs. per sq. in. load, (2) 10% deformation under 25 lbs. per sq. in. load, (3) start of permanent volume change without load, (4) mean coefficient of expansion, (5) cycles in 2900°F air-spalling test, (6) melting point, (7) thermal conductivity at 1000, 2000 and 2750°F. Various successful applications of this type of brick are described.

Development

The tendency in modern boiler design to increase ratings and furnace temperatures caused the start of experimentation with better refractories several years ago. After a careful study of the available materials, a sedimentary kaolinic clay was selected as the most promising.

The Clay

This material is a Georgia clay which occurs in a stratum underlying some of the well-known kaolin beds. It has the advantage of purity, unusual uniformity, and occurrence in commercial quantities. The microphotograph of the raw material in Fig. 1 shows almost pure kaolinite which accounts for the high and uniform melting point of 3200°F. On heating, this material converts to mullite and silicate glass as shown in the microphotograph in Fig. 2. The large proportion of mullite is of great value in imparting favorable characteristics to the finished product. The analysis of this material is:

Silica	51.96%	Calcium oxide	0.10%
Iron oxide	0.57	Magnesium oxide	0.22
Titanium oxide	1.73	Sulphur trioxide	0.04
Aluminum oxide	45.38		

The fusion value of this clay is taken on each carload entering the plant and has never varied more than 10°F. The most serious disadvantage of this kaolin is its large and continued shrinkage. This is shown by the curve in Fig. 3. This continued shrinkage makes it necessary to fire the brick at a temperature above the highest temperature it is called upon to withstand in service.

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[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February, 1928. (Refractories Division.) Revised copy received May 17, 1928.

[2] Babcock and Wilcox Fellow, Division of Industrial Coöperation and Research, Massachusetts Institute of Technology.

The high shrinkage also makes it impossible to fire brick free from cracks and serious distortion, without the addition of a large proportion of prefired grog. The high temperature, in itself hard to attain, makes it difficult to set the brick without serious kiln marking, squatting, and sticking.

Kaolins are generally so free from fluxes that it is necessary to fire at a high temperature in order to attain a reasonable degree of mechanical strength.

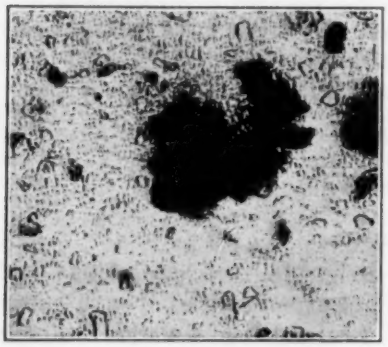

FIG. 1—Microphotograph of raw Georgia clay.

Early Experiments The chief poblem was to produce in a commercial kiln the high firing temperature required. A true optical temperature of over 3000°F was needed.

Other serious problems arose. The setting gave trouble because of squatting, sticking, and kiln marking. The temperature had to be maintained very close to the correct value, or overfiring and underfiring occurred. There was great difficulty in getting a perfectly even distribution of temperature. The kiln crowns would last only a few firings. The iron work of the kiln warped badly at these temperatures and the oil consumption was excessive.

First Production Kilns A suitable rectangular kiln was developed. The usual circular crown was replaced by a higher crown of catenary section which reduced the stresses materially and gave greater stability. These crowns gave several times the life of the old ones. The arch blocks were ground to size with great precision. The kiln was completely insulated, heavily on the walls and more lightly on the crown. Later on the side walls, troublesome skew back, and buckstays were eliminated, as shown in Fig. 4.

Mechanically atomizing burners were adopted to produce a quick firing with close control, for the kaolinic material used will stand very rapid firing. This also reduced the fuel consumption.

Cost A satisfactory brick was now being produced. It stood up well in laboratory tests and was giving quite phenomenal service in certain difficult installations. The manufacturing cost, however, was very high because (1) the major percentage of the material in the brick had to be fired twice to temperatures over 3000°F, (2) fuel and kiln upkeep costs were very high, (3) firing temperature was so high that the setting had to be made with great care to prevent sticking and marking, and (4) due to the abrasiveness of the mix, molding was expensive.

Firing the Grog It was realized that before a commercial product could be turned out the manufacturing process must be revised. The first problem attacked was the firing of the grog.

A kiln was finally constructed that would continuously turn out uniform hard-fired grog with a fairly low oil consumption. Temperatures high enough to melt the material being treated could be easily attained, so a careful temperature controlling mechanism was required.

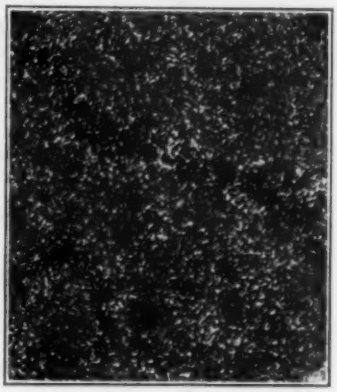

FIG. 2.—Microphotograph of same material fired to 3100°F (100×).

Molding It was found that a soft-mud brick machine, strengthened with alloy steel and with special molds, would turn out brick substantially free from laminations (Fig. 5). These brick were then repressed to give accurate dimensions. The wear on the molds and dies was great, making frequent replacements necessary. Bins, conveyers, and automatic weighing machines were used to obtain exact proportions and to cut down labor.

Firing the Brick The most serious problem of all was the firing of the brick. The high temperature required, and the rapid firing rate allowable, made the adoption of a tunnel kiln appear to be the most logical step. A small tunnel kiln was operated successfully. The bricks were so placed as to be heated evenly with the maximum of exposure. This allowed a very rapid firing rate, limited only by the time required for the heat to penetrate to the center of the brick.

Light Weight Brick At this time there was developed a special brick of the same material, but with a higher porosity than the standard brick, for use primarily on ships where furnace linings of light weight and good insulating properties are desirable. This brick weighs less than five pounds, is a comparatively good insulator, and yet will withstand more severe temperature conditions than a first class fireclay brick.

Tank Block There was also developed from this material a tank block with a minimum porosity. This was produced by a careful sizing of the grog and the correct proportioning of the bond.

Properties of the Kaolinic Fire Brick

The brick now produced has the following properties as compared with other high grade bricks. The properties of the lightweight brick and the tank block are also given.

Property	Average of 3 first-quality Pa. bricks	Average of 3 first-quality Mo. bricks	Kaolinic fire-brick	Light-weight kaolinic brick	Kaolinic tank block
Start of deformation under 25 lbs./sq. in. load	2100°F	2175°F	2700°F	2450°F	2825°F
10% deformation under 25 lbs./sq. in. load	2725°F	2750°F	2900°F	2620°F	3000°F
Start of permanent volume change without load	2300°F	2400°F	2900°F	2900°F	3000°F
Mean coefficient of expansion/°F	.0000028	.0000032	.0000024	.0000024	.0000024
Cycles in 2900°F air-spalling test	14	19	20		
Melting point, oxidizing atmosphere	3065°F	3095°F	3200°F	3200°F	3200°F
Corresponding cone	31	31+	35+	35+	35+
Thermal conductivity B.t.u./hr./sq. ft./1 in. at 1000°F	9.3		11.6		16.0
At 2000°F	10.5		13.3		18.8
At 2750°F	11.3		14.2		20.6

Service Results

Stationary and Marine Boilers

The initial installations of this brick were limited to oil-, gas-, and tar-fired furnaces. The most important factors controlling the life of brickwork in stationary boiler furnaces, fired with these fuels, are (1) deformation due to load, (2) softening or fusing from high temperatures, and (3) spalling from frequent and rapid changes in temperature. This brick has proved very successful in this type of service.

The economy of using the kaolinic fire brick for stationary oil-, gas-, and tar-fired boilers, even at its rather high price, has been fully demonstrated in practically every central station using these fuels throughout the east and south, and to a lesser degree in the middle west.

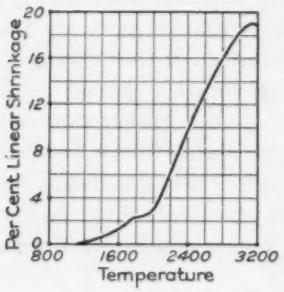

FIG. 3.—Firing shrinkage of Georgia clay.

The economy of using a fire brick which eliminates frequent shut-downs and loss of time is still greater in marine use. Further, the expense of relining marine boilers is greater than that of relining stationary boilers as it is necessary to replace not only the fire brick, but also the insulating material. The controlling factors in the life of furnace linings in marine service are softening from high temperatures and spalling from frequent temperature changes. The former trouble arises from the fact that space is at a premium on board ship, and the B.t.u.'s released per cubic foot of furnace volume are extremely high in comparison with stationary work. For the same season the burners

are often set close to the side walls which causes direct impingement of the oil flame on the brickwork. Frequent changes in temperature occur particularly in vessels having short runs in which case the burners are shut down and lighted off at frequent intervals to take care of manœuvering in port, and to take care of the intermittent load imposed by the steam cargo-winches. Some of the largest American vessels are now using this fire brick successfully in their boilers.

FIG. 4.—A small kiln with a catenary crown.

The light weight kaolinic fire brick which, when made in the standard 9-inch size, weigh less than 5 lbs., are being used by the Navy in the scout cruisers now under construction with a saving in weight of about two tons per boiler or sixteen tons per ship. This brick demonstrates the possibility of making an extremely porous and light kaolinic brick which is sufficiently resistant to the action of the hot gases in a furnace to be exposed to them, and yet is sufficiently strong to withstand the vibration, pitching, and

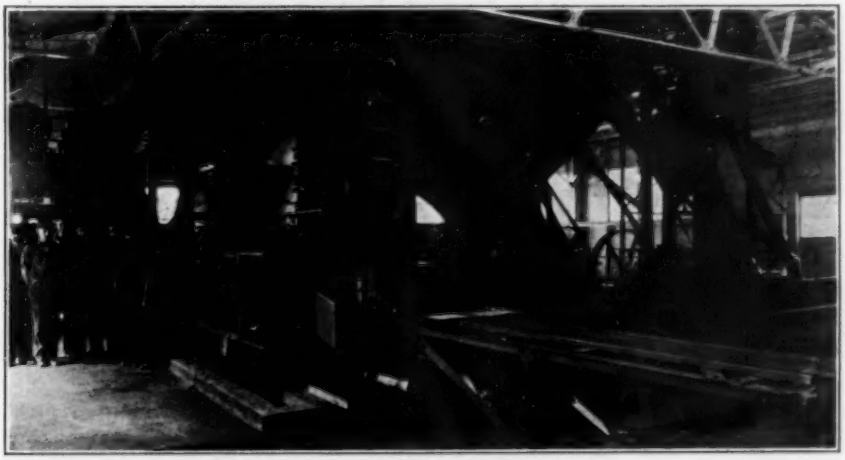

FIG. 5.—Automatic brick machine.

rolling of ships, such as destroyers running at high speed. It also has the advantages of a comparatively low coefficient of conductivity which is important in certain types of marine boilers with only $4^1/_2$-inch refractory furnace lining.

Industrial Furnaces This brick has been successful in oil-fired and gas-fired kilns, such as are used for firing china, pottery, terra cotta, electric porcelains, and sanitary ware. It is used principally in the fire mouths and under structure where trouble is usually experienced with softening due to high temperatures and deformation due to load.

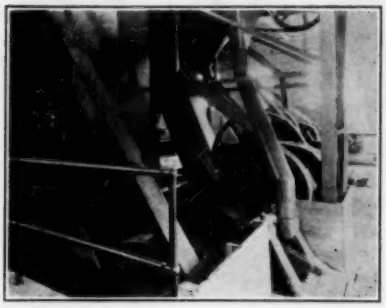

FIG. 6.—Crushers and elevators.

It is also used for enameling furnaces and muffle furnaces and is of value in the piers and floors on account of its load-bearing capacity at high temperatures.

It is also being successfully used in forge furnaces, annealing furnaces, and billet-heating furnaces in the steel industry. Practically all of these cases are examples of types of service where the linings are subjected to high temperature, and also abrasion from the charge.

Coal-fired Boilers Kaolin brick may also be used in coal-fired equipment where the question of ash and slag exists. With mechanical stokers experiencing furnace troubles through mechanical abrasion and through the erosion caused by the scrubbing action of the gases passing over the surface of the brickwork at high velocity, the density and hardness of the kaolinic fire brick is of considerable value. Furthermore, where slag adheres but does not actually run, the penetration by slags is less with kaolin brick than with a more porous brick. This condition is exemplified in pulverized fuel-fired boilers of which there are many successful installations. Of course, the good load-bearing capacity of this brick is also of advantage in furnaces fired with pulverized fuel, as they are usually very large in comparison either to hand- or stoker-fired jobs.

The limiting condition for this brick in coal-fired furnaces, is where the ash-fusion point of the coal is so low or the furnace temperatures so high that the slag actually runs. In cases such as these the resistance of the kaolinic fire brick, in comparison with a high grade fireclay brick, is not sufficiently greater to warrant the price differential.

Glass Tanks Laboratory tests and preliminary service results with many different glasses indicate that a kaolinic tank block mixture is well worth its price. The penetration below the slag line is practically nothing, and the erosion along the slag line is very much slower than with fireclay blocks.

FURTHER DATA ON OPERATING COST OF A PLATINUM-WOUND RESISTANCE FURNACE[1]

By Edward Orton, Jr. and J. F. Krehbiel

ABSTRACT

The results derived on the cost of operating a platinum-wound resistance furnace after one year's use, are presented.

One year ago, a new platinum-wound electric resistance furnace for high temperatures, was described. The term of its use at that time was too brief to enable any safe conclusions to be deduced on the longevity, cost of operation, and cost of maintenance.

The following data have been selected from the mass of records, as bearing on the points involved.

Number and Duration of Firings

Firings made (altogether)	100
Hours under current	2476
Hours operating on Chromel coil only	1200
Hours operation on platinum coil, with Chromel coil used as a "booster"	1276
Average hours per firing	24.76

Current Consumption

Total kw. hours used for electric furnace work	4979
Kilowatt hours used on the Chromel coil, operating singly	2000
Kilowatt hours used with all coils operating	2979
Average kw. hours per firing	49.79

Operating Costs

Average firing 49.79 kilowatt × $0.032 per kilowatt-hour paid for municipal electric current	$1.49

Maintenance Costs

Replacement of one Chromel coil after 34 firings. This coil was in the *inside* of the 8-inch fireclay tube (sewer pipe) which composed the outer member of the heating plant.[2] The heat it received there from the platinum coil, one and one-half inches inside of it, was too severe. In replacing this coil, eleven pounds of No. 3 Chromel A wire was wound *outside* of the fireclay pipe, bringing its distance from the platinum coil up to about $2^1/_2$ inches. This replacement cost $26.38.

Changes in Electrical Input

The last ten firings, have been made to cone 10 in going up in 12 hours on the Chromel coil to about 800°C. Then both coils are put on, finishing the last five hours or more at the rate of 20°C per hour.

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[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February, 1928. (Refractories Division.)

[2] *Jour. Amer. Ceram. Soc.*, **10** [5], 373–87 (1927).

[3] *Ibid.*, **10** [5], 379 (1927).

The current consumption for these ten firings has been 48, 47, 47, 48, 44, 44, 43, 48, 47, 47, or a mean of 46.3 kw., and a fluctuation of just five kilowatt hours from the highest to the lowest.

The furnace is not changing at all rapidly in its electrical constants.

STANDARD PYROMETRIC CONE COMPANY
COLUMBUS, OHIO

MINERAL CONSTITUENTS AND ORIGIN OF A CERTAIN KAOLIN DEPOSIT NEAR SPOKANE, WASHINGTON[1]

By G. E. Goodspeed[2] and A. A. Weymouth[3]

ABSTRACT

This paper discusses petrographic and mineralogic features of kaolinite and associated minerals from a certain kaolin deposit near Spokane, Wash. Here the kaolin occurs in dikes, veinlets cutting a sandy material, and has field relations and mineral associations that are not in harmony with the usual conception of residual deposits due to weathering. The evidence points strongly to endomorphic action or perhaps even direct primary origin from highly aqueous magmatic solutions.

Introduction

From ten to fifteen miles southeast of Spokane, in the vicinity of Freeman, Mica, and Chester, there are several clay deposits which have been and still are the source of considerable kaolin material.

Southeast of Spokane is a highland area forming the divide between the Spokane Valley on the north and the Palouse district on the south. The general elevation of the Spokane Valley is 2000 feet and of the Palouse district 2500 feet, while higher portions of the divide, such as Mica Peak, range from 3500 to 5000 feet. The kaolin deposits occur along small north-south valleys cutting this highland, and along the southern, and in one instance, the northern border of the area.

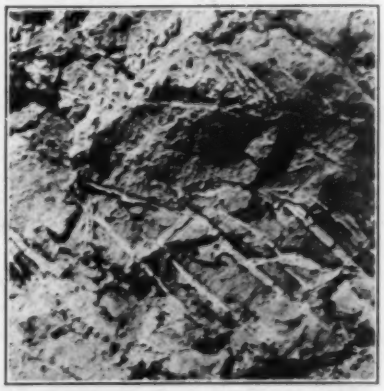

FIG. 1.

Spokane Valley to the north of this area is of glacial origin and is filled with glacial débris. To the south are the Tertiary basalts and basaltic soils. The rocks in this area are at least pre-Tertiary in age and consist of metamorphics intruded by granitic rocks and their offshoot dikes.

These kaolin deposits may be classified in three types; the origin of two of the types is quite evident.

(1) Two miles east of Chester, is a deposit clearly of lacustrine origin, as the pit exposes clay layers containing an abundance of fossil leaves. Some of this clay is gray, some yellow-brown and red. It was probably derived from the residual kaolins of the granitic areas.

[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February, 1928. (Terra Cotta Division.) Received January 30, 1928. Published by permission of the Director, U. S. Bureau of Mines.

[2] Consulting Mineral Technologist, U. S. Bureau of Mines, Seattle Sta.; Asst. Prof. in Geology, Univ. of Wash.

[3] Graduate student, Geology Dept., Univ. of Wash.

(2) Near Mica and Freeman are deposits which may be classed as colluvial, that is, formed by but a slight amount of transportation, perhaps nothing more than a hillside wash. Stratification in these deposits may be quite evident, and coarse fragments of undecomposed feldspar are often found. They probably originated in the wash from surrounding areas of undecomposed feldspathic material, the fine clay being derived from the kaolinite deposits, which are to be described.

(3) The other type of kaolinite deposit in this region, well shown by the pit at Freeman, has been called residual, and in the sense that the material has not been moved the classification is entirely correct, as may readily be seen by very casual examination.

FIG. 2.

Here the main mass appears to be a rather loosely consolidated quartz sand with a kaolinite cementing material, traversed by vertical dikes of kaolinite, quartz, and mica. From these vertical dikes are numerous stringers of nearly pure kaolinite. Many of these branch stringers are horizontal and appear to have followed the bedding planes in the sandy material; certain parallel stringers, not horizontal, suggest that they follow original cross-bedding planes. (See Figs. 1 and 2.)

The larger vertical dikes are from a few inches to about one foot wide and contain numerous granular masses of $^1/_4$- to $^1/_2$-inch quartz making up perhaps 20% of their total content. (See Fig. 3.) They also contain flakes of muscovite, including some several inches across. The quartz and mica are in a matrix of white kaolinite and finely divided mica or sericite. No trace of the former existence of feldspars is apparent. Under the petrographic microscope this white matrix is seen to consist entirely of minute crystals of kaolinite and sericite, the kaolinite crystals being far more minute than the sericite.

There is a remarkable evenness in the kaolinite, with no evidence of even the slightest amount of original feldspathic material. At Freeman it is said that a well has been sunk for 285 feet in exactly the same ma-

terial. Thin sections of the kaolinite show no evidence of original feldspars, not even traces of crystal outline. They do show, however, concentration of magnetite along the contact with the sandy material.

Taking the deposit as a whole the following minerals (in the general order of their abundance) are present:

Sandy matrix	Kaolinite dikes
(1) quartz (sandy matrix)	(1) kaolinite
(2) mica	(2) quartz (kaolinite dikes)
(3) zircon	(3) mica (sericite)
(4) magnetite	(4) ilmenite
(5) ilmenite	(5) monazite
(6) anatase	(6) zircon
(7) monazite	(7) topaz
(8) cassiterite	(8) cassiterite
(9) rutile	(9) rutile
(10) tourmaline	(10) tourmaline
(11) staurolite	(11) lepidolite

Recognition of the rarer minerals necessitates using the methods of sedimentary petrography,[4] which in brief depend on the fact that the high specific gravity of the rarer minerals permits their concentration by the flotation of the lighter constituents in bromoform (specific gravity, 2.85).

Light Minerals (Specific Gravity Less Than 2.85)

(1) Quartz (sandy matrix) The grains vary greatly in angularity, some being subangular while others are well rounded. Most grains are deeply embayed. In thin section the quartz grains are seen to be but slightly cemented. The grains are very regular in size. No signs of mechanical crushing can be noted. Every grain is free from the staining which would have resulted from the action of meteoric waters.

The inclusions are numerous and irregular[5] and consist of zircon, magnetite, and fluid contained in cavities and are ordinarily very minute, crushing to finer than 200-mesh being necessary to liberate them. Some inclusions nearly as large as the enclosing quartz grain can, however, be seen.

(kaolinite dikes) The quartz grains making up the granular masses in the dikes differ from the quartz of the sand matrix in that they are entirely free from inclusions and are not rounded.

(2) Mica The form muscovite is very abundant in large flakes throughout the kaolinite-quartz dikes. It is often filled

[4] C. S. Ross, "Preparation of Sedimentary Materials for Study," *Econ. Geol.*, **21** [5], 454 (1926).

R. D. Reed, "Heavy Mineral Investigation of Sediments," *Econ. Geol.*, **19** [4], 320 (1924).

[5] Wm. Mackie, "Sands and Sandstones of Eastern Moray," *Trans. Edinburgh Geol. Soc.*, **7** (Art. 23), 148–72 (1893-98).

with inclusions of the colored micas. In the sandy matrix the muscovite is finely divided. It also occurs in the finely-divided or shredded form of sericite.

(3) Kaolinite Small veins and dikelets of kaolinite occur through the quartz-sand matrix. The kaolinite dikelets when seen in thin sections are free from quartz except along the edges where grains have been pulled or dropped into it. Tiny stringers project irregularly from the larger dikelets into the sand matrix. There is no evidence that feldspar has been present, as no remnants of that mineral are found. The kaolinite itself is remarkably crystalline, and no cloudy fragments are noticeable. Within the kaolinite dikelets are found particles of sericite, mica, ilmenite, zircon, monazite, tourmaline, lepidolite, cassiterite, and rutile.

Heavy Minerals

Disseminated throughout the quartz-sand matrix, within, though near the edges of the kaolinite dikelets and in the form of inclusions within the quartz grains, are found the minerals of a specific gravity greater than 2.85.

(4) Zircon Zircon ($ZrO_2 \cdot SiO_2$) is by far the most abundant of the heavy minerals. Usually it is in well-shaped crystals with the first order prism and pyramid, varying in size from 0.04 to 0.2 mm. Grains with inclusions are rare. The color varies from a colorless variety to the smoky type (esignated as jargon.

FIG. 3.

d**5) Magnetite** This mineral ($FeO \cdot Fe_2O_3$) is very abundant and is usually found associated with the sandy matrix and as inclusions in the quartz. No magnetite is found in the main kaolinite dikelets but is present along the edges of the small offshoots from the main dikelets. The grains are seen as octahedrons and as rounded masses. Enough magnetite is present in the quartz after separation from the kaolin to necessitate its removal by tabling, as it causes black spots in white firing pottery bodies.

(6) Ilmenite This mineral ($FeO \cdot TiO_2$) is found associated with the magnetite but differs in its magnetic properties. It is abundant in the kaolinite dikelets. Some of these grains have altered to leucoxene. The ilmenite would also cause black spots in white firing pottery bodies.

(7) Anatase Anatase (TiO_2) is rather difficult to detect because of its intense blue-black coloring; consequently it may be more common than now thought. It is found associated with the magnetite and ilmenite and may be the result of alteration of the ilmenite. Rarely is it found included within the kaolinite veinlets. No crystal form has been observed.

(8) Monazite Monazite ((Ce, La, Di)PO_4) occurs sparingly in the sandy matrix as dusky grains, usually rounded, although fractured prismatic sections have been noticed.

(9) Topaz Topaz ($(AlF)_2SiO_4$; usually with hydroxyl) occurs sparingly as well-defined basal plates from which the identification is very easy.

(10) Cassiterite This is a rather rare mineral in this deposit. When found it is scattered through both the kaolinite and quartz sand matrix. Cassiterite (SnO_2) always occurs as well-shaped crystals showing prisms with pyramidal terminations and may be readily distinguished from rutile or anatase by its lower index of refraction.

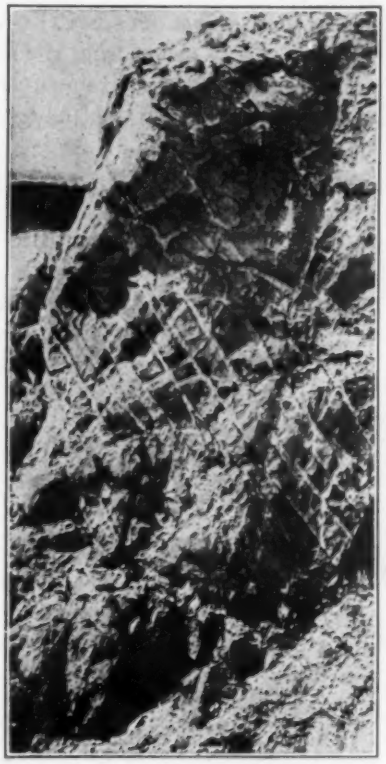

FIG. 4.

(11) Rutile Rutile (TiO_2) often occurs as knee-shaped twins, with an angle of divergence of 65°. It resembles staurolite and cassiterite but differs in twinning and index of refraction.

(12) Tourmaline Tourmaline ($H_9Al_3(B \cdot OH)_2Si_4O_{19}$) is very rare in this deposit and is noticeable by the marked pleochrism, which is dark brown to yellowish brown.

(13) Staurolite The rarest of the heavy minerals in this deposit is staurolite ($H_2O \cdot 2FeO \cdot 5Al_2O_3$). It resembles cassiterite, except for the biaxial character and higher birefringence. It is represented by flat, broken prisms and is very slightly pleochroic.

Types of Deposits

The source of residual deposits in the United States is usually described as the atmospheric weathering of suitable feldspathic material,

such as granite, granodiorite, gneiss, or pegmatite. Some European and English geologists, however, have explained deposits comparable to these as being a result of pneumatolytic action at the closing stages of batholithic intrusion; *i.e.*, a result of postvolcanic processes rather than atmospheric agencies.[6]

Residual deposits caused by weathering are likely, under most circumstances, to grade from the decomposed material above to the fresh rock beneath. Under the extreme conditions of a tropical climate weathering may extend to depths of nearly 400 feet, as do certain shales in Brazil, and to 200 feet, like the granite in the Dakaap gold fields of South Africa.[7] Deposits of this type might be expected to be mantlelike and to have a greater areal extent than depth, factors of vital importance with regard to development.

On the other hand, a deposit of magmatic origin would probably be somewhat limited in areal extent, occurring along lines of fissures or in irregular or domelike or chimneylike bodies in the upper portions of intrusive masses or in the invaded rocks immediately above a cupola, so that lateral extension would not be expected, although greater downward extension might be possible.

For these reasons it will be seen that an accurate detailed classification of clay deposits, especially a residual deposit, is not merely of scientific value but may have a real practical bearing, perhaps effecting the expenditure of considerable funds for development work.

The Freeman kaolinite deposit just described is unquestionably a residual deposit in the sense that it is *in situ*. The network of undisturbed dikes is ample proof of this conclusion. The simplest way of dismissing the question is to consider deposits like these to be due to weathering. (Fig. 4.)

The numerous clay deposits in this region would seem to bear out this hypothesis until it is realized that many of these deposits are clearly of the transported type and could have been formed by the erosion of a few primary deposits.

Warmer climatic conditions were probably present in western Washington during Eocene time, as shown by the coal seams, fauna, and flora. Similar climatic conditions may have been prevalent enough in eastern Washington to produce a residual clay. Here the weathered zone would have to be well over 300 feet thick, covering a rugged

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[6] Fundamental Principles of Petrology, by Ernst Weinschenk. Translated by A. Johannsen, McGraw-Hill, 1916.

F. W. Clarke, "Data of Geochemistry," U. S. Geol. Surv., *Bull.*, No. 770, p. 495.

H. Rösler, *Neues Jahrb. Beil.*, **15**, 231 (1902).

[7] Treatise on Sedimentation by W. H. Twenhofel, p. 11, Williams and Wilkins Co., 1926.

topography having a relief of over 2000 feet, and subsequently most of this would have been eroded away, leaving but a few remnants.

Although weathering hypothesis for these white clays is perhaps the most obvious, nevertheless the writers believe that the field evidence does not accord with it. Moreover, microscopic study of the material would seem to indicate that these deposits cannot be so easily explained by this hypothesis.

Inadequacy of the Weathering Hypothesis

The reasons for this may be tabulated as follows:

(1) The deposits appear to be somewhat limited in areal extent. If they represent remnants of an old weathered mantle one might infer that more deposits would be expected along the base of previously existing highlands.

(2) Uniform intensity of the decomposition, showing no gradation into unweathered material. There is no indication whatever of any structures such as concentric or spheroidal weathering.

(3) Rocks of the surrounding region are feldspathic, *i.e.*, gneisses, granites (granodiorites), aplites, and pegmatites, and do not show any white clay deposits, although in many places the effects of weathering are apparent by the disintegrated granitic soil or disintegrated granite, in which the feldspars are not much altered.

(4) The kaolinite is found in dikes, dikelets, and smaller veins and embayments and in the quartz-sand matrix.

(5) The kaolinite is perfectly crystalline, and no presence of feldspar is noticeable.

(6) The minerals associated with the kaolinite are those of the last residual remnants of an acidic magma which would be excessively high in volatile matter.

(7) There is no considerable staining of the kaolinite by alteration products, such as is noticeable in common cases of weathering.

Conclusions

There are several rather peculiar facts about the Freeman kaolinite deposit. The sandy material into which the dikes intruded have rounded quartz grains which suggest an original sedimentary origin. This opinion is further strengthened by what is apparently the injection of kaolinite stringers along bedding planes.

The presence of a suite of pneumatolytic minerals is evidence of the proximity to the contact of a crystallizing magma.

It seems probable that the following took place: (1) the sandy material was originally a sandstone, or rather a quartz rock with an argillaceous cementing material; (2) it formed the upper part of the roof of a stock

or batholith; (3) this rock was intensely altered by pneumatolytic action during the intrusion of the granitic magma, giving rise to minerals characteristic of such action.

(A) Endomorphic Origin During the final stages of the crystallization of the batholithic, aplitic, and pegmatitic phases were formed and injected into the roof rock. The magma of these offshoots contained such a large amount of volatile constituents that all feldspars were changed to kaolinite either immediately or by the continued flow of these fugitive constituents. Here the endomorphic action was so complete that no traces of feldspars remain.

The complete absence of even the faintest outline of a feldspar, however, makes it difficult to imagine that this mineral ever did exist. If this was the case, the kaolinite crystallized directly as kaolinite and is of primary origin.

(B) Primary Origin When crystallization of the batholith was completed fractures in the roof rock gave access to aqueo-igneous solutions cool enough to allow, and so high in volatile matter as to necessitate, crystallization of the alumina content as kaolinite instead of feldspar. Sericite and low-temperature quartz (in the larger dikes) were also formed.

In other words, the kaolinite appears to have crystallized out of an aqueo-magmatic solution as a primary constituent. The abundance of sericite might account for the alkalis of this magma. The last phases of a magma wet enough to produce a hydrous silicate like kaolinite would be expected on account of the volatile constituents to produce an intense metamorphic action, so that any feldspathic material in the nearby invaded rock would be completely kaolinized.

The hypothesis of primary kaolinite is further strengthened by the fact that secondary silica, such as chalcedony or opal, is entirely absent. If the kaolinite had formed as a product of the usually accepted reaction, at least some of the secondary silica would have been expected to have resisted leaching. The kaolin material from the dikelets is shown to be pure kaolinite by chemical analysis, almost exactly corresponding to the formula.

Some reference has been made to the economic bearing of a deposit such as this if it is or is not due to weathering. A hypothesis of the endogenetic or of the primary nature suggests even more important relations to development work.

Acknowledgment Field examination and a preliminary report on this deposit was made by the senior author during the summer of 1926 in connection with the nonmetallics investigations of the Northwest Experiment Station, U. S. Bureau of Mines.

Hewitt Wilson, Consulting Engineer, Nonmetallics, U. S. Bureau of Mines, has

materially aided the writers by furnishing some additional material and by many helpful suggestions.

The writers wish to thank R. E. Fuller for the excellent photographs. The glaring white of the kaolinite dikes against a background of white sandy material is a difficult subject for contrast.

Discussion

BY FRANCIS A. THOMSON: This paper is particularly interesting because there are a number of the same type of kaolin deposits in Latah County close to Moscow. The conclusion concerning the inadequacy of the weathering hypothesis is correct; in fact, many have felt for some time that the best clays in this part of the country are produced under conditions which have protected them from weathering, *e.g.*, where they are protected by a thin basalt cover. This is particularly noticeable in the Joel pit near Troy, Idaho. The explanation of these deposits is to be found rather in what the authors have termed "endomorphic origin" than in primary origin. No one has as yet proved that kaolin is a strictly primary mineral and it is to be doubted whether the evidence adduced by the authors of this paper is sufficient to support them in their advocacy of a process not heretofore recognized by the best geological opinion.

G. E. GOODSPEED:[8] Insofar as they apply to the Idaho deposits F. A. Thomson's remarks are very pertinent. We have examined some of these deposits, in particular, the Joel pit, and in a previous, though as yet unpublished report for the Bureau of Mines, it is pointed out that for these deposits the endomorphic hypothesis is to be preferred. In fact, in one of the pegmatite dikes in this Idaho occurrence there are traces of original feldspars quite close to the surface, while farther down in the pit, softer, more massive clay material prevails. This is just the reverse of what would be expected in a deposit due to atmospheric weathering.

The presence of remnants of feldspars shows that this mineral actually formed from the pegmatitic magma and was later altered by the volatile constituents liberated as the magma crystallized. The kaolinite in this case could be considered as an endogenetic product formed within the igneous rock mass by the final action of the volatile constituents set free by the completed crystallization of the magma.

An action similar to this may have taken place in the formation of the kaolinite deposit at Freeman, near Spokane, Washington, yet the absence of any indication of the original feldspars is rather peculiar, and for this reason the hypothesis of primary kaolinite is also proposed for these deposits, even though it is unusual.

[8] Reply to F. A. Thompson's discussion.

A NEW APPARATUS FOR A RAPID SEDIMENTATION ANALYSIS[1]

By C. J. Van Nieuwenburg and Wa. Schoutens

ABSTRACT

A new apparatus for the continuous determination of the cumulative distribution curve of particle size is described. It is based on the known principle of determining the changes in concentration in one definite layer. Instead of drawing off portions of the liquid, the changes are measured by the apparent weight of a suspended body. Two points of the curve are determined independently by measuring the residue in suspension and by an elutriation in the same vessel. A source of errors, the contraction of the cross-section in the neighborhood of the suspended body, is eliminated. The apparatus makes it possible to determine reliable distribution curves with any liquid within a few hours and avoids some sources of errors of previous methods.

Introduction

For the determination of the distribution of particle size over the range of 1 to 20μ, for which elutriation takes too much time, three principles are now generally in use, (1) the Wiegner[2] apparatus, (2) the Sven Odén[3] balance, and (3) a determination of the change in concentration of a definite layer in the suspension.

The Wiegner tubes present several difficulties. When the concentration of the suspension in the settling tube is low, the difference in level between the two tubes is also small and the readings are inaccurate unless very expensive devices for photographic or other indirect registrations are used. When the concentration of the suspension is sufficiently increased, the settling phenomenon is disturbed by the action of the particles on each other. Moreover, the calculation of the cumulative distribution curve[4] from the actual readings is intricate and often inaccurate.

The readings of the Odén balance and its modification are also intricate; moreover, there is always the chance that some of the settled particles will fall off the scale; the forces resulting from the "vacuum" under the scale cannot be calculated.

Therefore, the only rational principle in sedimentation analysis is that given by Robinson[5], by Jennings, Thomas, and Gardner[6], and by Krauss.[7] This principle is based on the fact that when a suspension, originally homogeneous, begins to settle after a lapse of time (t) in a

[1] Received March 8, 1928.

[2] *Landw. Versuchsstat*, **91**, 41 (1918).

[3] *Intern. Mitt. Bodenk.*, **5**, 257 (1915); *Kolloid. Zeit.*, **26**, 100 (1920).

[4] The function giving the fraction in weight (y) of all those particles that have a radius greater than (x).

[5] *Jour. Agric. Soc.*, **12**, 306 (1922).

[6] *Soil Sci.*, **14**, 485 (1922).

[7] *Intern. Mitt. Bodenk.*, **13**, 147 (1923).

layer (x) units under the surface, only those particles which have a rate of settling less than x/t are in exactly the same concentration as in the original suspension. So, when the changes of concentration in an arbitrary layer are plotted against the particle size calculated by means of Stokes' law from the values of x/t, we get at once the cumulative distribution curve.

Krauss, Robinson, and Jennings determined the changes in the concentration by drawing off samples. The relative amounts of particles of different sizes can be calculated from the changes in density of the samples or by weighing the dry matter in a given volume.

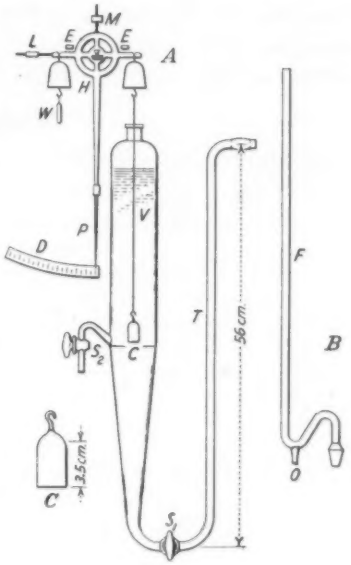

FIG. 1.

This frequent drawing off seems to be quite an unnecessary complication as well as a source of error. It must cause a certain disturbance of the normal settling process. It was decided, therefore, to determine the loss of matter at a certain place in the liquid by means of the suspended weight of an immersed body. Such a body was described by Schurecht,[8] who used a relatively long plummet instead of a small body and this made it impossible to register directly the concentration changes in a definite layer. The increase in suspended weight in his case is only a measure of change in concentration over quite a long range. To calculate the real cumulative distribution curve from these measurements would involve the same difficulties as were encountered by Wiegner and by Odén.

The New Apparatus

The new apparatus as given in Fig. 1 consists of (1) a sedimentation vessel, V, which has the form of a Schöne tube, (2) a long conical underpart which prevents the formation of vortices when a current of water is let in through the stop-cock, S_1 and the tube, T.

The vessel is filled up to a certain mark with the suspension. In it is suspended by means of a flexible copper wire of about 0.1 mm. thickness, a small hollow glass body, C, 30 to 40 mm. long and 15 to 25 mm. in diameter in such a way that it takes its place at about the height

[8] *Jour. Amer. Ceram. Soc.*, **4** [10], 812 (1921).

of the side tube, S_2. It is weighted by a few drops of quicksilver to make its weight under water about 3 to 5 g. It is suspended from a sensitive balance, H. The left side of the balance is provided with a small scale and a counterweight, W, of about the same weight in air as the apparent weight of the immersed body in suspension. The small screws L and M regulate the sensitiveness and the zero reading on the scale D. The balance may be arrested by means of a clamp, E. To transform the sedimentation vessel into an elutriation apparatus according to Schöne, a tube F, of the usual model is kept ready.

Mode of Operation

Measurements are always carried out in a room where the temperature is kept constant within not more than 1°C above or under a mean value. This is absolutely necessary for measurements where accuracy is desired.

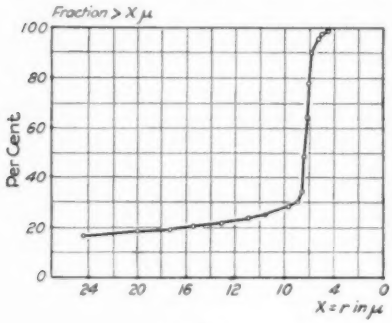

FIG. 2.

The powdered material is dried at 110°C. Exactly 20 g. are weighed, stirred with water in a mortar, and washed through a conical sieve of 30 meshes per linear cm. into the sedimentation vessel. The residue left on the sieve is added to the elutriation residue, referred to later.

While introducing the sample, the stop-cock S_1 is closed. The vessel is then filled with distilled water up to the mark, in this case 800 cc., and the body, C, is introduced into the suspension and connected with the right scale of the arrested balance.

Compressed air is then blown through the stop-cock S_1 in order to homogenize the suspension. When this current of air has passed through the liquid for about a minute, the stop-cock S_1 is closed and at the same time a stop-watch is released. This moment is reckoned as the beginning of the sedimentation. Some seconds later, when the worst disturbances in the liquid will have ceased, the arresting mechanism of the balance is loosened.

It is evident that during the first minute the pointer of the balance will oscillate so heavily that it is quite impossible to take any readings. This does not matter in the least. Readings begin only when the conditions are quite stabilized, *i.e.*, after two minutes. The pointer is then moving regularly and slowly to the left as might be expected; the suspended matter is beginning to settle, and the mean specific gravity at the height of the immersed body decreases; the buoyancy on it also decreases, so the apparent weight increases with an amount

that is equal to the weight of the suspended matter that has disappeared from the volume of the body minus the weight of the water which has taken its place.

Knowing the sensitivity of the balance, the weight of matter which has settled since the arbitrary starting point (2 minutes) can be calculated by multiplying the readings on the scale, reckoned from that same starting point and now expressed in terms of weight (mg.), with a factor, $D/D-1$, or more generally, $D/D-d$ (D = specific gravity, suspended matter, d = specific gravity, pure liquid) when a liquid other than water is used.[9]

While sedimentation is going on the readings of the pointer on the scale are taken as often as necessary, every 2 or 5 minutes or oftener, when the pointer moves rapidly. This is continued until all particles necessary to this experiment have settled deeper than the immersed body. As a rule this requires about one hour.

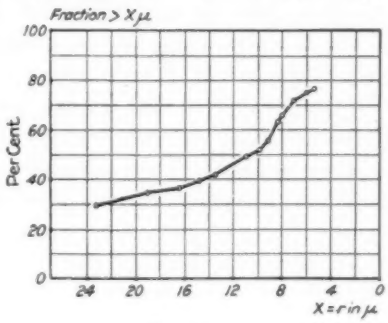

FIG. 3.

With a height of fall (distance between level and center of body) of about 25 cm. and materials of a specific gravity of about 2.5 all particles greater than about 4μ will have settled. If desired the readings may be continued, but if particles of a smaller radius (*e.g.*, to 1μ) are to be included it is advisable to use another apparatus having a shorter fall.

When the sedimentation is thus arbitrarily concluded the next move is to draw off a portion (about 20 cc.) of the remaining liquid through the side tube, S_2. Ten cubic centimeters of this liquid are evaporated in a weighed dish. This makes it possible to calculate the percentage of the original matter having a radius smaller than that of the last reading.

Then the sensitivity of the balance is determined by placing small weights (50, 100, 150, 200 mg.) on the scales. The readings of the pointer are noted and a mean value for the sensitivity is calculated from them.

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[9] The specific gravity of the material must be known for this calculation as well as for the application of Stokes' sedimentation formula. At first this was determined in a pycnometer in the usual way. But in the settling vessel the suspended matter is saturated with microscopic air bubbles. So it seems to be far better to determine the specific gravity in the same condition, *i.e.*, after passing a stream of air through the filled pycnometer. Experience shows that this gives a fairly constant, though undeniably wrong value for the specific gravity, some 5% below the real value, but more in accordance with the conditions of affairs in the sedimentation vessel.

Four sets of figures have now been obtained (see Table II): column (1) the time-intervals, column (2) the actual readings of the pointer, column (3) these same readings minus the position of the pointer at the starting point (2 min.), *i.e.*, the deflections from the arbitrary zero, and column (4) the fraction (in per cent of the original matter) that has disappeared since the second minute of the time-intervals from the special layer in which the body is suspended. This fraction is calculated by multiplying the figures of column (3) with $100 \times D/D-1$ and dividing them by the sensitivity and the original matter in the volume of the body (volume of body times amount originally present in 1 cc., *i.e.*, 25 mg.).

The distance is also known between the level of the liquid and the immersed body, or the height of fall. This distance is in reality not exactly constant, but increases slightly. The beam of the balance, however, is very short, so that the vertical displacement of the body is only 10 to 15 mm. The mean value of the depth of the center of the body under the level of the liquid, is taken as height of fall, generally 20 to 25 cm. For practical purposes the inaccuracy caused by the fact that the body has some dimensions (3 to 4 cm.) may also be neglected though certainly it causes a slight error in the curves.

When this known height of fall is divided by the time-intervals, column (1), the velocities of fall are obtained, column (5). From these velocities the radius of the disappeared particles is calculated by means of Stokes' formula.[10]

$$v = \frac{2}{9} g \frac{r^2(D-d)}{\eta} \text{ c.g.s. units}$$

where v = velocity of fall
g = acceleration of gravity = 981
r = so-called "equivalent radius", *i.e.*, the radius of a spherical body that would fall with the same velocity as the particle, which is certainly not spherical at all.
D = specific gravity of suspended matter
d = specific gravity of pure liquid
η = coefficient of internal friction of the pure liquid
(all in c.g.s. units)

These units are not very useful, so the formula is transformed for a special purpose as follows:

$$v = fr^2(D-d), \text{ where } f = \frac{2}{9} g \frac{1}{\eta} \text{ c.g.s.}$$

Hence $f = \frac{2}{9} \cdot 981 \cdot \frac{1}{\eta} \cdot 10^{-8} \cdot 60$, when r is expressed in μ, velocity in cm. per minute, η in c.g.s. units.

[10] This original theoretically sound formula is preferred rather than one of the empirical formulas, since it seems that there is no reason at all to believe that these latter are in any way more exact than that of Stokes.

The mean values for η (water) are taken from the Landolt-Börnstein tables

$\eta = 0.0179$ c.g.s. at 0°C
$\eta = 0.0131$ at 10°C
$\eta = 0.0101$ at 20°C

When these values are substituted in the above expression for f, the result is:

$f = 0.00730$ at 0°C, 0.0100 at 10°C and 0.0130 at 20°C
v in cm./min. $= 0.00730\, r^2(D-1)$ at 0°C (r in μ) or, for water

$$r(\text{in } \mu) = 11.7\sqrt{\frac{v}{D-1}} (v \text{ in cm./min.}) \text{ at } 0°C$$

$$= 10.0\sqrt{\frac{v}{D-1}} \text{ at } 10°C$$

$$= 8.8\sqrt{\frac{v}{D-1}} \text{ at } 20°C$$

or generally

$$r = A\sqrt{\frac{v}{D-1}} \text{ at } t°C$$

The values of the coefficient A have been interpolated between those of 0, 10, and 20° and the data are given in Table I.

TABLE I

VALUES OF A FOR WATER AT DIFFERENT TEMPERATURES*

t in °C	A	t in °C	A	t in °C	A
0	11.7	9	10.15	18	9.0
1	11.5	10	10.0	19	8.9
2	11.3	11	9.85	20	8.8
3	11.15	12	9.7	21	8.7
4	10.95	13	9.6	22	8.6
5	10.8	14	9.45	23	8.55
6	10.6	15	9.3	24	8.45
7	10.45	16	9.2	25	8.4
8	10.3	17	9.1	26	8.3

* r is expressed in μ and v in cm. per minute

It is evident from this table, that it is absolutely necessary to perform the whole operation at a moderately even temperature, and quite senseless to give values of the coefficient in the sedimentation formula, alleged to be exact even up to the third decimal place, without any indication at all about the temperature, an error that is not seldom committed in technical papers on this subject.

With the aid of the above formula and the table of coefficients the equivalent radius of the settled particles can be calculated at the time-intervals of column (1) and the figures of column (6) are obtained (Table II).

The figures of column (4) combined with those of column (6) give directly (*i.e.*, without any numerical or graphical differentiation as with the Wiegner or Odén apparatus) the cumulative distribution curve of particle size, for the present, however, with an unknown integration constant.

All the fractions have been calculated from an arbitrary starting point (2 min.). Therefore, in the real distribution curve all the fractions are higher than the provisional fractions by an amount equal to the unknown fraction that had been already settled in the first two minutes or even left behind on the filling sieve. In other words, the form of the curve is known, but not its exact place in the diagram. (The form also is proved to be only approximate.)

In the apparatus two independent means for the determination of the unknown integration constant are disposed of. The first has been already mentioned, namely, the evaporation residue of 10 cc. from the remaining liquid drawn off at the end of the sedimentation through the side tube, S_2.

It seemed wise, however (and experience has shown it to be correct in this respect), to determine the integration constant in another way, quite independent. To this end, the sedimentation vessel has been built as an elutriation apparatus after Schöne. When the sedimentation is ended, the vessel is provided with the tube, F, by means of a ground joint and a water current introduced through S_1 from a Mariotte flask in such a way that the linear velocity of the current in the cylindrical part of V is constant and exactly known. As a rule a linear velocity of 4 to 5 cm. per minute was used. The settled material, stirred previously by means of compressed air, is then elutriated, so that all particles smaller than about 15μ (material with a specific gravity of about 2.5) are washed away. When the liquid which leaves the vessel is quite clear, after one or two hours, the residue is washed into a large beaker, evaporated, and dried.

When no great accuracy is required a much more convenient and rapid method is to pass the remaining liquid through a glass filter crucible. To this residue is added any residue on the 30-mesh filling sieve. Its weight divided by the total amount of original matter (20 g.) gives the fraction of particles larger than the equivalent radius corresponding with the elutriation velocity and calculated in exactly the same way by the transformed Stokes' formula.

It is assumed that the end of the sedimentation period corresponds with an equivalent radius of $x\mu$ and the elutriation velocity with one of $y\mu$. The value of the fraction corresponding with $y\mu$ can be interpolated in the provisional distribution curve. In this curve the fraction

$>x\mu$ minus the fraction $>y\mu$ may be $p\%$. It is evident that the sum of $p\%$ plus the fraction $<x\mu$ (from the residue in suspension) plus the fraction $>y\mu$ (from the elutriation) ought to be 100%. If that is so, then it is certain that no gross errors have been made.

The Error of Contraction

In our experiments, however, this ideal was never realized. A great many powders were investigated with the apparatus and a sum of 105 to 110% instead of 100% was always found. After some time it was concluded that this might have been expected. The provisional distribution curve must be somewhat disfigured by an increase in length in the direction of the fraction axis. The actual concentrations of suspended matter, indeed, are greater directly around our suspended body than in other parts of the liquid. The particles falling down are more or less crowded in those regions, because the cross-section is smaller at the height of the body than above or under it. Consequently all variations of the concentration as registered by the pointer are greater than might be expected, when the settling process had its normal course. An effort was made to eliminate this "error of contraction" by reducing all variations in weight by a factor $P-p/P$, where P is the cross-section of the settling tube and p the section of the suspended body. This, however, was not completely successful.

The fact that there are two independently determined points of the real curve comes exactly to the purpose. The true difference ($q\%$) between the fractions $>y\mu$ and $>x\mu$ is known from the determinations of the residual fractions of the elutriation and the sedimentation, whereas $p\%$ is found from the provisional curve. (See above.) Evidently the "contraction factor" by which the determined variations in weight must be multiplied to get the true values, is q/p.

The results of this reduction are given in column (7). When finally all these figures are increased with the amount necessary to bring the fraction $>x$ on the true value known from the residue in suspension, column (8) contains the true fractions, which together with column (6) give the true cumulative distribution curve.

Results

(1) Refractory Highly Plastic Clay from Normandy

$t=20°C$, specific gravity (saturated with air) $D=2.52$; 20.0 g. in 800 cc. water
Volume of suspended body = 18.64 cc.
Cross-section of body = 4.48 cm².
Mean value of height of fall = 23.4 cm.
Residue in suspension at the end of sedimentation = fraction $<4.5\mu = 1.4\%$
Residue of elutriation = fraction $>16.6\mu = 19.8\%$
Sensitivity: one division of scale = 3.58 mg.

TABLE II

(1) Time (min.)	(2) Readings of scale	(3) Deviations from 2 min.	(4) Sedimentation (%)	(5) Velocity of fall (cm./min.)	(6) r	(7) Sedimentation corrected (%)	(8) Sedimentation corrected (%)
2	6½	0	0	11.7	24.4μ	0	16.6
3	8	1½	1.9	7.8	20.0μ	1.7	18.3
4	9	2½	3.2	5.9	17.3μ	2.8	19.4
			3.6			16.6	
5	9¾	3¼	4.1	4.7	15.5μ	3.6	20.2
7	11	4½	5.7	3.35	13.1μ	5.1	21.7
10	13	6½	8.3	2.34	10.9μ	7.4	24.0
13	14½	8	10.2	1.80	9.6μ	9.0	25.6
20	17	10½	13.4	1.17	7.7μ	11.9	28.5
25	19	12½	15.9	0.93	6.9μ	14.1	30.7
27	22	15½	19.8	0.86	6.6μ	17.6	34.2
29	35	28½	36.3	0.81	6.4μ	32.2	48.8
31	48½	42	53.5	0.75	6.2μ	47.5	64.1
33	61	54½	69.5	0.71	6.0μ	61.7	78.3
35	71½	65	82.8	0.67	5.8μ	73.5	90.1
40	76½	70	89.1	0.58	5.4μ	79.1	95.7
45	78	71½	91.0	0.52	5.1μ	80.8	97.4
60	79	72½	92.4	0.39	4.5μ	82.0	98.6

Meaning of Columns

(1) Intervals in minutes
(2) Readings of scale
(3) Readings of scale minus reading at the time (2 min.)
(4) Fraction in weight settled since 2 min., calculated as follows:

$$\frac{\text{Values from column (3)}}{\text{Volume body} \times 25.0\,\text{mg.} \times \text{sensitivity}} \times \frac{D}{D-1} \times 100 =$$

$$\text{Values from column (3)} \times \frac{3.85}{18.64 \times 25.0} \times \frac{252}{1.52} = \text{values from column (3)} \times 1.27.$$

(5) Velocity of fall in cm. per min., calculated from column (1) and height of fall (23.4 cm.)
(6) Equivalent radius in μ, calculated from V by aid of the formula for 20°C

$$r = 8.8\sqrt{\frac{v}{D-1}} = 8.8\sqrt{\frac{v}{1.52}} = \sqrt{51v}$$

(7) Values from column (4) corrected for contraction. The fraction $> 16.6\mu$ is found by interpolation to be 3.6%. Hence the fraction between 4.5 and 16.6μ is found to be $92.4 - 3.6 = 88.8\%$, whereas in reality it is $98.6 - 19.8 = 78.8\%$. So the "contraction factor" $= \frac{78.8}{88.8} = 0.888$

(8) Values from column (7) increased with $98.6 - 82.0 = 16.6\%$. All calculations are easily performed by the slide rule.

The results of columns (6) and (8) give together the cumulative distribution curve as represented in Fig. 2.

(2) Finely Powdered Sample of Lepidolite

$t = 15°C$, specific gravity (saturated with air) $D = 2.67$ 20.0 g. in 800 cc. water
Volume of suspended body = 13.01 cc.
Cross-section of body = 2.0 cm.²
Cross-section of settling tube = 22.7 cm.²
Mean height of fall = 21.0 cm.
Residue in suspension at end of sedimentation = fraction $< 5.6\mu = 22.7\%$
Residue of elutriation = fraction $> 15.5\mu = 38.5\%$
Sensitivity: one division of scale = 2.86 mg.

TABLE III

(1) Time (min.)	(2) Readings of scale	(3) Deviations from 2 min.	(4) Sedimentation (%)	(5) Velocity of fall	(6) r	(7) Sedimentation corrected (%)	(8) Sedimentation corrected (%)
2	−1	0	0	10.5	23.3μ	0	29.7
3	+3	4	5.6	7.0	19.1μ	4.7	34.4
4	5	6	8.4	5.25	16.5μ	7.0	36.7
			10.5		15.5		
5	7½	8½	11.9	4.20	14.8μ	10.0	39.7
6	9½	10½	14.8	3.50	13.5μ	12.4	42.1
7½	12½	13½	19.0	2.80	12.1μ	15.9	45.6
9	16	17	23.9	2.34	11.0μ	20.0	49.7
11	18	19	26.7	1.91	9.9μ	22.3	52.0
13	21	22	30.9	1.62	9.2μ	25.9	55.6
15	27½	28½	40.0	1.40	8.5μ	33.5	63.2
17	30	31	43.5	1.24	8.0μ	36.4	66.1
22	34½	35½	49.9	0.96	7.1μ	41.8	71.5
30	37½	38½	54.1	0.70	6.0μ	45.3	75.0
35	39½	40½	56.9	0.60	5.6μ	47.6	77.3

The results of columns (6) and (8) give the cumulative distribution curve as represented in Fig. 3.

Meaning of Columns

(4) Values from column (3) $\times \frac{2.86}{13.01 \times 25.0} \times \frac{267}{1.67}$ = values from column (3) $\times 1.405$.

(6) Equivalent radius calculated by aid of $r = 9.3 \sqrt{\frac{v}{D-1}} = \sqrt{52v}$ for 15°C and $D = 2.67$

(7) Values from column (4) corrected for contraction. The fraction $> 15.5\mu$ in column (4) is found by interpolation as 10.5%. Hence the fraction between 5.6 and 15.5μ is found as $56.9 - 10.5 = 46.4\%$, whereas in reality it is $77.3 - 38.5 = 38.8\%$. So the "contraction factor" $= \frac{38.8}{46.4} = 0.837$

(8) Values from column (7) increased with $77.3 - 47.6 = 29.7\%$

Conclusion

Experience has proved that with this apparatus cumulative distribution curves may be determined that show a great many more details than curves from Krauss, Jennings, and Robinson. Indeed these curves are practically continuous. As many points as wanted can be determined whereas the older methods give only a relatively small number of points, through which the curve is drawn, of course without any details at all. The advantage of the present method over Wiegner and Sven Odén has been described in the introduction.

When the "contraction factor" for a special combination of sedimentation vessel and suspended body is known, it is superfluous to perform the elutriation, which makes it even possible to get distribution curves with nonaqueous liquids or aqueous solutions, *e.g.*, of a certain p_H in a very short time (within three or four hours), including the calculation. This is an advantage in many respects. It saves labor, it improves the evenness of temperature, and in ceramic plant control it will reduce the lapse of time between an error in the granulometric composition of the slip and the moment of its discovery.

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STUDY OF CHINA BODIES OF BELLEEK TYPE[1]

PAUL F. COLLINS

ABSTRACT

After a preliminary study of Belleek bodies of four compositions, using three different frits and firing to three temperatures, a further study was conducted using the most promising of the three frits as the basic frit and three new frits containing some different ingredients. A standard body was used in the later study. Results obtained are enumerated and discussed.

Introduction

This type of body is peculiar in the use of a vitrifying agent consisting either of a glassy frit or a previously vitrified or sintered material. The oldest body of this type is the early French "pâte tendre," which may be represented thus:

Body	(%)	Frit	(%)
Frit	27	Salt peter	14.7
Chalk	17	Chalk	16.5
Marl	7	Sand	68.8
Sand	49	(Maturity at about cone 8)	

The modern application of this idea is the Belleek ware which originated in England and was later transferred to Ireland from whence it derived its trade name.

This early Belleek may be classed as a soft porcelain or glazed Parian. It was rich in feldspar. It consisted, to the best of our knowledge, chiefly of a local feldspar and china clay brought from Cornwall. This Belleek ware became eminent because of its outstanding qualities, namely: thinness, extremely high translucency, lightness, and toughness of fired body, and rich, creamlike, clear luster in ivory tones. There is no record of the exact percentage compositions of the raw material reported as composing Belleek ware, other than the composition which has been considered basic for this ware:

Frit	(%)	Body	(%)
Feldspar	60	Pulverized frit	50
Whiting	20	Ball and china clay	40
Flint	20	Flint	10

This body matured at cones 6 to 7. The present Belleek bodies undoubtedly vary somewhat from this.

With the idea of learning more regarding the use of artificial vitrifying agents, the following study was undertaken. In this investigation, the purpose was to develop (1) an earlier vitrification of the product in question; (2) a much denser body; (3) a product of more definite properties than one in which the progress of vitrification depended

[1] Presented at Annual Meeting, AMERICAN CERAMIC SOCIETY, Atlantic City, N. J., February, 1928. (White Wares Division.) Submitted as thesis requirement, Ceramic Engineering Dept., Ohio State University, 1927.

on the development of eutectics as a part in the development of the ware; and (4) reduction of the amount of vitrifying agent required and of the firing temperature required for a given effect through use of a previously fused vitrifying agent.

Outline of Research

The lack of previous research gave little upon which to base such a study; therefore as original vitrifying mixtures, the combinations were chosen that seemed promising from the present viewpoint. These compositions were as follows:

No. 1	Canadian feldspar	60
	Whiting	20
	Flint	20
No. 2	Canadian feldspar	60
	Bone ash	30
	Flint	10
No. 3	Canadian feldspar	60
	Dolomite	20
	Flint	20

It was decided that these mixtures were to be fritted separately and allowed to flow into water, thereby cracking the frit. At 1400°C, however, these mixtures would not flow, even when held at this temperature for four hours. It was decided, therefore, to replace the Canadian feldspar, in part, by an albite feldspar. This alteration was sufficient to cause No. 1 frit to flow readily. The other compositions still refused to flow, so by decreasing the bone ash and feldspar content and increasing the flint content, No. 2 mixture was made to flow. By decreasing the feldspar content alone and increasing the flint content, No. 3 frit was made to flow.

The compositions of the final batches as melted were:

	No. 1 (%)	No. 2 (%)	No. 3 (%)
Canadian feldspar	30	25	25
Soda feldspar	30	25	25
Flint	20	30	30
Whiting	20		
Bone ash		20	
Dolomite			20

Frits 1 and 2 had a greenish tinge in the glassy state and were very hard and resist crushing. These frits were hand-crushed to pass 8-mesh before introduction into the body mix. Frit 3 was nearly pure white, was well cracked by running into water, and could be further crushed in the fingers. The temperature obtained in frit furnace was about cone 15. The time required for fritting operation was three hours.

Three body mixes were decided upon and a fourth was to consist of one-third of each of the others. American clays were to be used along with the English china clay. These bodies were as follows:

	(*A*)	(*B*)	(*C*)	(*D*)
Pulverized frit	50	40	40	43
Clay	40	50	40	43
Flint	10	10	20	14

Each one of the frits was added to each of the body mixes, thereby making a total of twelve different bodies. (1) The clay used for bodies (A) and (C) was 15% No. 4 Kentucky ball clay, 10% Florida kaolin, and 15% English china clay. (2) The clay used for body (B) was 20% No. 4 Kentucky ball clay, 10% Florida kaolin, and 20% English china clay. (3) The clay for body (D) was one-third of the sum of the above clays.

These mixes were introduced into ball mills, with sufficient water to form a thick slip and ground for twelve hours. The slip as it came from the mill was then sufficiently thick for easy casting without further adjustment. All of the bodies cast very nicely. The ware was cast very thin (one-eighth inch in green state as a maximum) in the form of small flower crocks 2 by 2 inches outside dimensions and allowed to air dry.

Notes on Dry Ware

All bodies containing Frit 3 tended on casting to develop a porous structure, such as is observed when slip is poured into a hot mold. C–3 was extremely weak in the dry state.

Body (A–1)	Pure white in color
Bodies (B, C, D–1)	Inferior white
" (A, B, C, D–2)	Brownish "
" (A, B, C, D–3)	Dirty "

Firing Treatment

The ware was then properly saggered with cone plaques in alternate corners and fired in direct, gas-fired, downdraft kilns. Three firings were made, in which the temperatures obtained within the saggers were respectively, cones 5, 6, and 8, with firing time 24 hours.

Results of Fired Trials

(Summary of cone 5, 6, and 8 studies)

(A–1) Color: pink to white at cones 5 and 6; slight ivory shade noted at cone 8.
Body: best maturity at cone 8.
Translucency: improves only to cone 6.
Shrinkage: average at cone 8, very low at cone 5.
Absorption: approaching vitrification, cones 6 to 8.

(A–2) Color: distinct and very good ivory tints at cones 5, 6, and 8.
Body: best maturity at cone 5, as evidenced by slight self-glazing. Pronounced self-glazing at cone 6 and decided distortion at cone 6 and above.
Translucency: excellent at cone 5; slightly clearer at cone 8.
Shrinkage: excessive at cone 5.
Absorption: vitreous at cone 5.

(A–3) Color: improves to cone 8, from a dead white at cone 5 to a cream white at cone 8.
Body: immature at cone 5. Best maturity cones 5 to 6. Decided slumping and distortion at cones 6 and 8.
Translucency: none at cone 5, fair at cone 8.
Shrinkage: moderate at cone 5; (very impractical body at cones 5, 6, and 8).

(B–1) Color: improves from dead white at cone 5 to a slight cream or ivory at cone 8.
Body: approximately mature at cone 8.
Translucency: improves to cone 8 (fair).
Shrinkage: average at cone 8.
Absorption: nearly vitreous at cone 8.

(B–2) Color: an excellent and beautiful ivory at cones 5, 6, and 8. Color becomes glassy at cone 8.
Body: mature at cone 5; (slight self-glaze); decided self-glazing and evidence of overfiring at cones 6 and 8.
Translucency: excellent, clear at cone 5.
Shrinkage: average at cone 5.
Absorption: vitreous at cone 5.

(B–3) Color: blue or grayish white at cone 5 (reducing conditions?) to cream white at cone 8.
Body: immature; decided slumping, self-glazing and distortion at cones 6 and 8.
Translucency: none at cone 5; fair at cone 8 (impractical body).

(C–1) Color: excellent white at cone 6; pinkish white at cone 5 to pure white at cone 8.
Body: best maturity at cone 6; slight self-glazing; immature with slight distortion at cone 5.
Translucency: none at cone 5; improves and at cone 6 is very good.
Shrinkage: moderate at cone 6.
Absorption: vitreous at cone 6.

(C–2) Color: very good ivory at cones 5, 6, and 8.
Body: best maturity at cone 5; slight self-glazing; decided slumping, distortion, and self-glazing above cone 5 to cone 8.
Translucency: excellent.
Shrinkage: excessive at cone 5.
Absorption: vitreous at cone 5.

(C–3) Color: best at cone 5 (cream white).
Body: mature, slight self-glazing and slight distortion and cracking at cone 5; this tendency increases above cone 5.
Translucency: fair at cone 5 and improves to cone 8.
Absorption: vitreous at cone 5; (impractical above cone 5).

(D–1) Color: color improves to cone 6; dead white.
Body: best maturity at cone 8.
Translucency: improves only to cone 6.
Shrinkage: average at cone 8.
Absorption: nearly vitreous at cones 6 to 8.

(D–2) Color: good ivory.
Body: mature at cone 5; slight self-glazing and pinholed surface; increased self-glazing, distortion, and slumping from cones 6 to 8.
Translucency: best at cone 5.
Shrinkage: excessive at cone 5.
Absorption: vitreous at cone 5.

(D–3) Color: slight ivory at cones 5, 6, and 8; undesirable and impractical at cones 5, 6, and 8; distortion and slumping above cone 5.

Notes

Frit 1 gives the most refractory body, in regard to the maturing temperature, and imparts to all bodies in which it is used, a dull surface. It tends to develop an ivory body at cone 6 and above. Maturity is reached slightly above cone 8. The translucency imparted by this frit does not develop until cone 6 and does not improve at temperatures above cone 6.

Frit 2 undoubtedly lends itself best toward the production of a very good ivory body of highest translucency.

Frit 3 causes slumping and distortion. The use of this frit is therefore limited and it should not be employed in any considerable amount at temperatures exceeding cone 5. A very short vitrification range is indicated in these bodies, which displayed immaturity at cone 5 and slight distortion and slumping at cone 6 which increases at cone 8. Under some conditions this frit seems to develop an ivory body.

Color Rating of Bodies in Order of Preference.

White: (C–1) at cone 6, (B–1) at cone 8, (D–1) at cone 6, (A–1) at cone 8, (B–3) at cone 5, and (A–3) at cone 5.

Ivory: (B–2) at cone 5, (A–2) at cone 5, (C–2) at cone 5, (D–2) at cone 5, (C–3) at cone 5, and (D–3) at cone 5.

Translucency Rating of Bodies in Order of Preference

(B–2) at cone 5, (A–2) at cone 5, (C–2) at cone 5, (D–2) at cone 5, (C–1) at cone 6, (C–3) at cone 5, (D–1) at cone 6, (A–3) at cone 5, (B–3) at cone 5, (A–1) at cone 8, (B–1) at cone 8, and (D–3) at cone 8.

Outstanding Bodies of Entire Study

(1) (B–2) and (2) (A–2) as outstanding ivory bodies; (C–1) as outstanding white body.

The compositions of these choice bodies are:

(B–2) Ivory

Frit	(%)
Canadian feldspar	25
Soda "	25
Bone ash	20
Flint	30

Body	(%)
Pulverized frit	40
No. 4 Ky. ball clay	20
Florida kaolin	10
English china clay	20
Flint	10

(A–2) Ivory

Frit
Composition same as (B–2)

Body	(%)
Pulverized frit	50
No. 4 Ky. ball clay	15
Florida kaolin	10
English china clay	15
Flint	10

(C–1) Pure White

Frit	(%)	Body	(%)
Canadian feldspar	30	Pulverized frit	40
Soda "	30	No. 4 Ky. ball clay	15
Whiting	20	Florida kaolin	10
Flint	20	English china clay	15
		Flint	20

Second Study

Encouraged by the above study, we attempted to enlarge our scope by using frits containing both dolomite and bone ash, and also whiting and bone ash. As Frit 2 previously proved most promising, it was chosen as the basic frit in this new study. The effect of adding a boric-acid frit to the standard body was also studied. The amount of frit incorporated in the body mix was limited to 30%. The old body cast exceedingly well so it was thought possible to cut the ballclay content in the new standard body. The china-clay and flint content were accordingly increased.

The following were the newly chosen vitrifying mixtures:

	No. 4 (%)	No. 5 (%)	No. 6 (%)
Canadian feldspar	35	25	25
Soda feldspar	35	25	25
Boric acid	30		
Flint		20	20
Bone ash		20	20
Dolomite		10	
Whiting			10

All of these frits fused and flowed readily. They cracked readily in water and varied from a light green to a white in color. They required nearly three hours for the fritting process and were easily crushed and pulverized.

The new standard body was taken as:

		(%)
(E)	Pulverized frit	30
	No. 4 Ky. ball clay	15
	Florida kaolin	10
	English china clay	25
	Flint	20

Each frit was added to this body, making three new fritted bodies. Each mixture was introduced into a ball mill, with sufficient water to form a thick slip, and ground for twelve hours. The slip as it came from the mill was then sufficiently thick for easy casting without further adjustment. All bodies cast very nicely. An attempt was made to keep the thickness of all of the castings uniform. The small flower pot mold was again used.

These bodies were considerably lighter in color, both in the slip form and in the dry state, than the former bodies. The trials were air dried and then properly saggered, with cone plaques in alternate corners, and

fired in direct, gas-fired, downdraft kilns to exactly cone 6. The firing was accomplished in twenty-four hours. The temperature gradient was maintained at 100° per hour after a uniform dull red heat was obtained throughout the kiln.

Results of Cone 6 Study

(E–4) Color: white to very slight ivory.
Body: mature, no self-glaze.
Translucency: excellent.
Shrinkage: moderate.
Absorption: slightly porous.

(E–5) Color: a beautiful ivory.
Body: mature, slight self-glaze.
Translucency: excellent.
Shrinkage: average.
Absorption: vitreous.

(E–6) Color: very good ivory; slightly inferior to E–5.
Body: mature, no self-glaze.
Translucency: excellent.
Shrinkage: average.
Absorption: nearly vitreous.

Summary of Cone 6 Study

Rating as to ivory color: (1) E–5, (2) E–6, (3) E–4, almost white.
Rating as to translucency: (1) E–5, (2) E–4, (3) E–6.
Rating as to degree of maturity: (1) E–5, (2) E–6, (3) E–4.

Summary of Entire Study

In regard to ivory color and translucency the following bodies are rated first in the order named:

(1) Ivory color: E–5, B–2, E–6, A–2.

(2) Translucency: E–5, B–2, A–2, E–6.

This investigation proves the value of previously fritted or at least calcined flux for porcelains. Other desirable properties displayed by these bodies are: (*a*) good dry strength in extremely thin cast ware, (*b*) extreme toughness in the fired state, (*c*) moderate firing temperature, cone 5, and (*d*) self-glazing at cone 8.

Explanations for Qualities Developed

(1) Ivory Color: due either to action of bone ash (tricalcium phosphate) on the iron oxide in the feldspar and clays, or to the attack of the previously fused flux on the iron and titanium oxide present as impurities in the clays.

(2) Translucency: due to the more advanced solution of the ball clays by the previously fused flux. If all the bone ash does not go into solution its structure would also contribute to development of translucency.

Warping and Deformation

An excess of fluxing material is undoubtedly present in all these bodies and it is probable that this can be reduced or replaced in part by potash feldspar to the benefit of the bodies in regard to warping and deformation. It is also probable that the free flint in the bodies can be replaced by bone ash, thus reducing the tendency to deform from slight overfiring. The bone ash if introduced raw should behave the same as in bone china.

SUSPENSION OF GLAZES AND BARIUM CARBONATE WATER[1]

By P. William Lee

ABSTRACT

Heavy setting, fine grinding, raw clay substances, hydrochloric acid, acetic acid, and corn starch are being discussed as the factors and ingredients for the suspension of glazes and wilkinite as a substance which will aid suspension for glazes and barium carbonate water.

Introduction

The problem of glaze suspension is an important factor to the ceramic industry in general and the prevention of fast settling of barium carbonate water is an item that terra cotta manufacturers can not overlook.

Factors Governing the Suspension of Glazes

There are many factors and methods by which the suspension of glazes can be controlled: (1) setting the glazes thick, (2) grinding the glazes very fine, (3) using the raw clay substance in the fritted glazes, (4) introducing corn starch in the glazes, (5) adding hydrochloric acid in the glaze batches, (6) using acetic acid in the glazes, and (7) introducing wilkinite in the glaze batches.

All of the above methods have merit and disadvantages, depending upon the kind of glaze and the particular systems of a plant.

Objections and Defects

Setting glazes thick has been a common practice to prevent fast settling. It helps to a great extent, especially if the glazes contain raw clay and other ingredients that are not fritted. If it is an entirely fritted glaze heavy setting would not help very much. The objections for setting the glazes thick are that they are hard to spray causing uneven glazing, and the glazes crawl and peel in sharp angles and deep crevices.

Grinding the glazes very fine has also been practiced extensively but it has many objections. It takes too long to prepare the glazes. It costs too much in grinding and in many cases the fine grinding will cause the glaze to bubble and lower its maturing temperature.

With fritted glazes the tendency has been to leave out the clay from the contents of the frit batch, and to use it as the sole factor of suspension of the glazes. This is necessary; in some cases, however, the raw clay is not required in the glaze content and frequently the amount of raw clay in the glazes does not give sufficient suspension.

Because of the various objections and inability to obtain sufficient suspension from the above-mentioned factors: setting heavy, fine grind-

[1] Received February 27, 1928.

ing, and using raw clay, other means have been tried, such as introducing corn starch, hydrochloric acid, acetic acid, and wilkinite in the glazes as the power of suspension.

Adding corn starch into glaze batches as a factor in suspension and adhesive or bonding power, is being practiced by many concerns. The objection to this is that it requires a high percentage of corn starch to be effective; also the amount of carbon produced by the corn starch causes the color of a glaze to change to a certain degree.

The use of hydrochloric acid in glazes has no especial objection since it requires a small amount and has no ill effect on the color of the glazes, but it causes the glaze batch to separate into two different charges if the glaze contains a raw carbonate of any kind. Its power of suspension is very small to entirely fritted glazes.

The acetic acid can be added to glazes or slips after they are ground. The amount of acetic acid needed varies with the kind of glaze, depending upon its ingredients. Like hydrochloric acid, it works best with raw glazes or glazes which contain raw ingredients and the effect is small with entirely fritted glazes.

The wilkinite, which is a better and possibly a purer grade of bentonite, can be used in glazes both raw and fritted as a power of suspension. The amount required for a fast settling glaze is about .5 to 1% at the most, and it is added to the batch before the glaze is ground.

The wilkinite fires to a cream color. To use an excessive amount to a white glaze would cause a slight change in color but not great enough to be noticeable. It is also economical to use commercially in comparison to the other factors and ingredients described in this article.

Suspension of Barium Carbonate Water

The terra cotta manufacturers who are using barium carbonate water in the mixing of terra cotta body often run into some difficulty on account of its settlement. This can be prevented by mixing .7 to 1% of wilkinite in the barium carbonate. The barium carbonate and the wilkinite should be ground in a ball mill with sufficient amount of water about an hour to insure a thorough mixing, then add this mixture into the water tank. The stirring apparatus of either compressed air or revolving disks will immediately enable the barium carbonate to mix with the required amount of water and further aid the suspension of the barium carbonate.

NORTHWESTERN TERRA COTTA CO.
CHICAGO HEIGHTS PLANT
CHICAGO HEIGHTS, ILL.

EQUATIONS AND TABLES FOR SHRINKAGE, EXPANSION AND DESIGN CALCULATIONS[1]

By A. E. R. Westman

ABSTRACT

Attention is drawn to an error in the equation for calculating linear shrinkage (per cent of dry length) from volume shrinkage (per cent of dry volume) which was given in the Report of the Committee on Standards, American Ceramic Society, *Year Book*, 1921–22. In order to avoid errors due to the use of incorrect equations, in future work, the more useful equations for making the ordinary shrinkage, expansion, and design calculations are derived and tabulated. To facilitate numerical computation, four figure tables are given by means of which the labor involved in the more usual ceramic calculations involving shrinkage and expansion can be greatly reduced. The use of the equations and tables is explained and illustrated by means of examples.

I. Introduction

Error in 1922 Year Book

In the Report of the Committee on Standards, American Ceramic Society, *Year Book*, 1921–22, the following equation is given for calculating linear shrinkage (per cent of dry length) from volume shrinkage (per cent of dry volume):

$$a = \left[1 - \sqrt[3]{\frac{b}{1-100}}\right] \times 100 \qquad (1)$$

in which a is the linear shrinkage and b is the volume shrinkage. This equation is not correct, as will be shown later, the correct equation being:

$$a = 100\left[\sqrt[3]{\frac{b}{100}+1} - 1\right] \qquad (2)$$

The use of the incorrect equation (1) in place of equation (2) introduces errors which are by no means negligible for relatively large shrinkages. This is shown by the data given in Table A, where a comparison is made of the values of linear shrinkage calculated by the incorrect equation (1) (column 2) and those obtained by means of the correct equation (2) (column 3) for a range of values of volume shrinkage. The differences, shown in the fourth column are quite appreciable for volume shrinkages greater than 10%.

Purpose of Paper

The present Committee on Standards is aware of the error in the 1922 *Year Book* which has been pointed out and have taken care to correct the equation in the new Standards Report.[2] It is the purpose of this paper to give a general discussion of all the calculations similar to that described above which are in general use in ceramics and to give equations and tables which

[1] Received July 7, 1928.

[2] *Jour. Amer. Ceram Soc.*, **11** [6], 451 (1928).

would prevent errors in future work and also facilitate the calculations.

Scope of Paper The calculations which will be discussed can be divided into three groups, (1) those dealing with relations between linear and volume changes, (2) those in which percentages calculated on one basis are converted into percentages based on other values, and (3) those in which the overall effect of two successive changes is calculated from data pertaining to the individual changes. An example of the first group of calculations is the calculation of linear shrinkage from volume shrinkage. The calculation of linear drying shrinkage (per cent of dry length) from the linear drying shrinkage (per cent of plastic length) belongs to the second group. The third group includes such calculations as the computation of design factors from a knowledge of the firing and drying shrinkage, *i.e.*, factors which can be used in calculating the plastic dimensions of a piece of ware from the dimensions which are desired for the finished product.

TABLE A

COMPARISON OF VALUES GIVEN BY CORRECT AND INCORRECT EQUATIONS

Volume shrinkage (per cent of dry volume)	Linear shrinkage (per cent of dry length) Equation (1) (incorrect)	Equation (2) (correct)	Difference
0	0.000	0.000	0.000
5	1.695	1.640	0.055
10	3.451	3.228	0.223
15	5.273	4.769	0.504
20	7.168	6.266	0.902
25	9.144	7.722	1.422
30	11.21	9.139	2.07
35	13.38	10.52	2.86
40	15.66	11.87	3.79
45	18.07	13.19	4.88
50	20.63	14.47	6.16

II. Relations between Linear and Volume Changes

Derivation of Equations Since volume changes can frequently be measured more accurately than changes in length, particularly in determinations of the drying and firing shrinkage of clays, it is often necessary to calculate linear per cent changes from volume per cent changes. An equation for making this calculation in the case of per cent expansions based on the initial values of length and volume can be derived as follows:

Let b = volume expansion (% initial volume)
a = linear expansion (% " length)
(initial dimensions of the specimen = those of unit cube)

Then, final volume of cube $= 1 + \frac{b}{100}$

$$\text{final length} = \sqrt[3]{1 + \frac{b}{100}}$$

$$(\text{linear expansion } (\% \text{ initial length})) = 100\left[\frac{\text{final length} - \text{initial length}}{\text{initial length}}\right]$$

Therefore,

$$a = 100\left[\sqrt[3]{\frac{b}{100}+1} - 1\right] \tag{3}$$

Equation (3) can be used for calculating linear changes from volume changes for per cent contractions or expansions based on initial or final values, provided a convention of signs is adopted and algebraic procedure[3] followed. It is more usual, however, in engineering work to use equations in which the data are substituted as positive arithmetic numbers. If this practice is followed, two equations are needed for handling the more usual cases of conversion of per cent volume changes to per cent linear changes and *vice versa*.

Common Cases Equation (3) is applicable in the arithmetic sense when per cent expansions based on initial values are being used. For per cent expansions based on final values and for per cent contractions (or shrinkages) based on initial values, the signs of a and b in equation (3) should be changed; for per cent contractions based on final values, the equation is directly applicable, the change from expansions to contractions being counteracted by the change of percentage basis from initial values to final values. Thus equations (2) and (3) are the same.

Table B gives the equations which should be used for converting volume to linear changes and *vice versa* for cases which commonly arise. These equations are to be used for arithmetic substitution. For per cent expansions based on initial values equation (4) in the third column of Table B should be used, and so on. Equations (6) and (7) in the fourth column of Table B are used for converting per cent linear changes to per cent volume changes and can be readily derived from equations (4) and (5).

Computing Tables Two four-figure tables, Tables I and II, for computing per cent linear changes from volume changes and *vice versa* will be found at the end of this paper. Under each equation in Table B the number of the table which can be used in place of the equations is indicated. In addition, at the top of each computing table, a number of the common cases of conversion for which it can be used are listed.

The numbers given in Tables I and II were calculated by means of Barlow's Tables.[4] Every tenth number was checked by direct calculation and then all the numbers were carefully verified by calculating first

[3] This procedure is discussed in detail in the Appendix.

[4] Barlow's Tables of Squares, Cubes, Square Roots, Cube Roots, Reciprocals of All Integer Numbers up to 10,000. Stereotype Edition. Spon and Chamberlain, 120 Liberty Street, New York (1926).

TABLE B

RELATIONS BETWEEN LINEAR AND VOLUME CHANGE

Nature of change	Percentage basis	Equations* for converting Volume change to linear change	Linear change to volume change	Percentage basis	Nature of change
Expansion	Initial values	$a = 100\left[\sqrt[3]{\frac{b}{100}+1}-1\right]$ Equation (4) (Table II)	$b = 100\left[\left(\frac{a}{100}+1\right)^3-1\right]$ Equation (6) (Table II)	Final values	Contraction (or shrinkage)
	Final values	$a = 100\left[\sqrt[3]{\frac{b}{100}-1}+1\right]$ Equation (5) (Table I)	$b = 100\left[\left(\frac{a}{100}-1\right)^3+1\right]$ Equation (7) (Table I)	Initial values	

* In the equations, a = % linear change, b = % volume change, and substitutions are to be made arithmetically.

differences. They are believed to be correct to the number of places given.

Use of Tables In both Tables I and II, the numbers given in the body of the tables are per cent linear changes. They correspond to the per cent volume changes shown in units to the left and right of the tables and in tenths across the tops of the tables. Thus, in Table I, the per cent linear change corresponding to a per cent volume change of 15.6 is found in the row labelled 15 at the right and left and in the column having 0.6 at its head, *i.e.*, it has the value 5.497.

When volume shrinkages are accurate to two places of decimals, which is seldom the case, it will be necessary to interpolate in the tables. This can be done readily by using the differences which are listed to the extreme right of Tables I and II. If three-figure accuracy is ample, as is often the case, the numbers in the tables can be rounded off in accordance with the usual rules without introducing appreciable errors.[5]

Tables I and II can be used for converting per cent linear shrinkages to per cent volume shrinkages by interpolating in the body of the tables. As this conversion is not required frequently, tables for making it directly were not prepared.

[5] If errors in determining the per cent volume changes are such that the values can be rounded off in accordance with the customary procedure, it does not follow that the corresponding per cent linear changes can be so rounded; investigation, however, showed that for the range of the values given in the tables, this consideration was unimportant.

Examples In preparing Table A, it was necessary to calculate the linear shrinkage (per cent of dry length) corresponding to the values of volume shrinkage (per cent dry volume) given in the first column of the table. In the classification used in Table B, the foregoing calculation came under the main group "contraction" and the subgroup having percentages based on "final values." It was evident, therefore, that equation (4) or Table II should be used. The correct values of linear shrinkage given in the third column of Table B could, therefore, be read directly from Table II. The reader may use the values in Table B in making sure that the method of reading Tables I and II is understood.

TABLE C

CONVERSION OF PERCENTAGE BASIS

Nature of change in size	Equations* for converting: Percentage of initial value to final value	Percentage of final value to initial value
Expansion	$c=\frac{100d}{100+d}$ Equation (8)	$d=\frac{100c}{100-c}$ Equation (10) (Table III)
Contraction	$c=\frac{100d}{100-d}$ Equation (9) (Table III)	$d=\frac{100c}{100+c}$ Equation (11)

* In the equations, $c=\%$ change based on final value and $d=\%$ change based on initial value; substitutions are made arithmetically.

In the foregoing example, no interpolation was necessary. The following example will show how this may be done. It is required to find the linear shrinkage (per cent of plastic length) which corresponds to a volume shrinkage (per cent of plastic volume) having a value of 25.27. By consulting Table B or the headings of Tables I and II, it is found that Table I may be used. From Table I the linear shrinkage for a volume shrinkage of 25.2 is read directly as 9.225, and the difference for numbers in the same row found to be 0.04. The interpolated value for 25.27 is obtained by adding .7 of the difference 0.04 to 9.225 giving the value 9.253. The calculations can be tabulated as follows:

Tabulated value for 25.2 $=9.225$
Interpolation 0.7×0.04 $=0.028$
Interpolated value for 25.27 $=9.253$

III. Change of Percentage Basis

Common Cases Changes in size may be expressed as percentages of either initial or final values. The former method is the more usual practice, the latter is commonly used in design work and is the method given by the Committee on Standards,[6] the linear

[6] Report of the Committee on Standards, AMERICAN CERAMIC SOCIETY, *Year Book*, p. 10, 1921–22.

and volume drying shrinkages being expressed as percentages of the dry lengths and volumes, respectively. Since both methods have their uses, it is convenient to have a simple procedure for converting percentages based on initial values to percentages based on final values and *vice versa*. Equations for making these conversions are given in Table C, where the common cases of conversion are classified.

Equations Equation (8) (Table C), which is used for converting expansions expressed as percentages of initial size to expansions expressed as percentages of final size may be derived as follows:

$$\begin{aligned}&\text{Let } d = \%\text{ expansion based on initial size}\\ &\quad c = \%\text{ expansion based on final size}\\ &\text{Initial size} = 1\\ &\text{Then, final size} = 1 + \frac{d}{100}\\ &\text{and } c = 100\left(\frac{\text{final size} - \text{initial size}}{\text{final size}}\right) = \frac{100d}{100+d} \qquad (8)\end{aligned}$$

Equation (9) in Table C may be obtained in a similar manner and equations (10) and (11) may be obtained directly from equations (8) and (9) respectively.

Computing Table Of the conversions classified in Table C, that most frequently required is the conversion of percentage shrinkage based on initial size to percentage shrinkage based on final size. This can be accomplished by arithmetic substitution in equation (9) or can be made directly by the use of Table III, which is given in the computing tables at the end of the paper. Table III can also be used for converting per cent expansions based on final size to per cent expansions based on initial size, in place of equation (10), Table C. The reverse processes can be executed directly by means of Table IV.

In Table III, a scale of percentages to be converted is given in units to the right and left of the body of the table and in tenths at the top of the table. The numbers in the body of the table are the converted percentages. They were obtained by finding the reciprocals of the series of numbers 1.000, 0.999, 0.998, etc., in Barlow's Tables,[4] subtracting one from each reciprocal, multiplying by 100, and then rounding to four figures. For the range of the table, the first significant figure of each reciprocal was one, so no actual calculation other than rounding off was necessary.

The numbers in the body of Table IV were obtained from the reciprocals of the series 1.001, 1.002, 1.003, etc., given in Barlow's Tables,[4] by subtracting the reciprocals from one, rounding to four figures, and multiplying by 100. These operations could be performed mentally, so calculation was avoided.

Both Tables III and IV were checked by first differences and by comparison with each other. Differences for use in interpolation are given to the right of each table.

Example It will be shown later that Tables III and IV can be used to good advantage in the calculation of design factors. The following example will illustrate their use in conjunction with Tables I and II in solving a variety of problems.

The volume drying shrinkage of a body is known to be 30.6% of its plastic volume; the per cent linear drying shrinkage based on the dry length is required. From Table I it is found that the per cent linear drying shrinkage based on the plastic length is 11.46%, and from Table III it is found that this corresponds to a linear shrinkage based on the dry length of 12.95%. Another procedure is to use Table III to find the per cent volume shrinkage based on the dry volume, obtaining the value 44.09%, and then use Table II to convert this to a per cent linear shrinkage giving the value 12.95% as before.

IV. Resultant Percentage Changes

Design Factors In ceramics it is frequently necessary to calculate the resultant effect of two consecutive changes in size. For example, the overall shrinkage due to drying and firing must often be computed from the drying and firing shrinkages. The overall or resultant linear shrinkage expressed as a percentage of the fired length is useful as a design factor in the design of molds, dies, etc. Resultant per cent changes and design factors may be calculated conveniently by means of the equations and tables which have already been described when used in conjunction with the equations which are given in the following section.

Equations Table D gives the equations which can be used for calculating the resultant change, Z, in per cent which is caused by a change of X per cent followed by a change of Y per cent, all three percentages being expressed in accordance with the same system. For example, if X is the linear drying shrinkage (per cent of initial or plastic length) and Y is the linear firing shrinkage (per cent of initial or unfired length), then Z, the resultant linear shrinkage (per cent of initial or plastic length), is given by equation (13), Table D. The same equation would be used if X, Y, and Z were volume shrinkages. For any particular problem, Tables I, II, and III can be used in converting the data into a form suitable for use with equations (12) and (13).

Computing Table Computing tables which can be used instead of equations (12) and (13) can be constructed quite easily, the numbers in the columns and rows of the tables forming arithmetic series. Such tables are, however, necessarily two-fold tables and for

accurate calculation either large tables or complicated interpolations are required. Since, on the other hand, equations (12) and (13) are quite simple, computing tables for their replacement were not included in this paper.

TABLE D

CALCULATION OF DESIGN FACTORS, COMBINATION OF CHANGES

Nature of changes	Percentage basis	Equation* for calculating resultant per cent change	Percentage basis	Nature of changes
Both expansions	Initial values	$Z=X+Y+\frac{XY}{100}$ Equation (12)	Final values	Both contractions (or shrinkages)
	Final values	$Z=X+Y-\frac{XY}{100}$ Equation (13)	Initial values	

* In the equations, Z = per cent resultant change or overall change, X = per cent change in first process (*e.g.* drying) and Y = per cent change in second process (*e.g.* firing). If X and Y are percentages of initial values, Z will be a percentage of the initial value; if X and Y are percentages of final values, Z will be a percentage of the final value.

Example The use of equations (12) and (13), Table D, can be illustrated by the following example. The volume drying shrinkage of a clay is 30.6% of its plastic volume, the linear firing shrinkage is 6.32% of its fired length, the resultant linear shrinkage expressed as a percentage of the fired length is required. By the use of Tables I and III, the linear drying shrinkage (per cent of final or dry length) is found to be 12.95. This can be combined with the linear firing shrinkage by means of equation (12), since both of them are expressed as percentages of final lengths, as follows:

$$X+Y=12.95+6.32=19.27$$

$$\frac{XY}{100}=\frac{12.95\times 6.32}{100}=0.82$$

$$Z=20.09$$

The resultant linear shrinkage expressed as a percentage of the fired length is therefore 20.1%. This value may be used as a design factor, mold dimensions being obtained by adding 20.1% to the desired ware dimensions.

V. Summary

Equations The following groups of equations have been given: (1) equations for showing the relations between volume changes and linear changes, (2) equations which may be used for changing the percentage basis of shrinkage or expansion data, and (3) equations for calculating the per cent change in size resulting from two successive, known per cent changes.

Table I

Four Figure Table for Converting:

(1) Volume Drying Shrinkage (per cent of plastic volume) to Linear Drying Shrinkage (per cent of plastic length),

(2) Volume Firing Shrinkage (per cent of unfired or dry volume) to Linear Firing Shrinkage (per cent of unfired or dry length), and

(3) Volume Expansion (per cent of final volume) to Linear Expansion (per cent of final length).

Per Cent Volume Change	Per Cent Volume Change										Per Cent Volume Change	Differences
	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9		
	Per Cent Linear Change											
0	0.000	0.033	0.067	0.100	0.134	0.167	0.200	0.234	0.267	0.301	0	.034
1	0.334	0.368	0.402	0.435	0.469	0.503	0.536	0.570	0.604	0.638	1	.034
2	0.672	0.705	0.739	0.773	0.806	0.840	0.874	0.908	0.942	0.976	2	.034
3	1.010	1.044	1.078	1.112	1.146	1.181	1.215	1.249	1.283	1.317	3	.034
4	1.352	1.386	1.420	1.455	1.489	1.523	1.558	1.592	1.626	1.661	4	.034
5	1.695	1.730	1.764	1.799	1.834	1.868	1.903	1.937	1.972	2.007	5	.035
6	2.041	2.076	2.111	2.146	2.181	2.216	2.251	2.285	2.320	2.355	6	.035
7	2.390	2.425	2.460	2.495	2.530	2.565	2.600	2.636	2.671	2.706	7	.035
8	2.741	2.776	2.812	2.847	2.882	2.918	2.953	2.988	3.023	3.059	8	.035
9	3.095	3.130	3.166	3.201	3.237	3.273	3.308	3.344	3.380	3.415	9	.036
10	3.451	3.487	3.523	3.559	3.594	3.630	3.666	3.702	3.738	3.774	10	.036
11	3.810	3.846	3.882	3.918	3.954	3.990	4.027	4.063	4.099	4.135	11	.036
12	4.172	4.208	4.244	4.281	4.317	4.354	4.390	4.426	4.463	4.500	12	.036
13	4.536	4.572	4.609	4.646	4.683	4.719	4.756	4.793	4.830	4.866	13	.037
14	4.903	4.940	4.977	5.014	5.051	5.088	5.125	5.162	5.199	5.236	14	.037
15	5.273	5.310	5.348	5.385	5.422	5.459	5.497	5.534	5.571	5.609	15	.037
16	5.646	5.684	5.721	5.759	5.797	5.834	5.872	5.909	5.947	5.984	16	.037
17	6.022	6.060	6.098	6.136	6.174	6.212	6.249	6.287	6.325	6.363	17	.038
18	6.401	6.439	6.477	6.515	6.553	6.592	6.630	6.668	6.706	6.745	18	.038
19	6.783	6.822	6.860	6.899	6.937	6.975	7.014	7.052	7.091	7.130	19	.038
20	7.168	7.207	7.246	7.284	7.323	7.362	7.401	7.440	7.479	7.518	20	.039
21	7.557	7.596	7.635	7.674	7.713	7.752	7.791	7.831	7.870	7.909	21	.039
22	7.949	7.988	8.027	8.067	8.106	8.146	8.185	8.225	8.265	8.304	22	.039
23	8.344	8.383	8.423	8.463	8.503	8.543	8.582	8.622	8.662	8.702	23	.040
24	8.742	8.782	8.822	8.862	8.903	8.943	8.983	9.023	9.063	9.104	24	.040
25	9.144	9.184	9.225	9.265	9.306	9.346	9.387	9.428	9.468	9.509	25	.040
26	9.550	9.590	9.631	9.672	9.713	9.754	9.795	9.836	9.877	9.918	26	.040
27	9.959	10.00	10.04	10.08	10.12	10.16	10.21	10.25	10.29	10.33	27	.040
28	10.37	10.41	10.45	10.50	10.54	10.58	10.62	10.66	10.71	10.75	28	.040
29	10.79	10.83	10.87	10.91	10.96	11.00	11.04	11.08	11.13	11.17	29	.040
30	11.21	11.25	11.29	11.34	11.38	11.42	11.46	11.51	11.55	11.59	30	.040
31	11.63	11.68	11.72	11.76	11.81	11.85	11.89	11.93	11.98	12.02	31	.04
32	12.06	12.11	12.15	12.19	12.23	12.28	12.32	12.37	12.41	12.45	32	.04
33	12.50	12.54	12.58	12.63	12.67	12.72	12.76	12.80	12.85	12.89	33	.04
34	12.93	12.97	13.02	13.07	13.11	13.15	13.20	13.24	13.29	13.33	34	.04
35	13.38	13.42	13.47	13.51	13.55	13.60	13.64	13.69	13.74	13.78	35	.04
36	13.82	13.87	13.91	13.96	14.00	14.05	14.09	14.14	14.18	14.23	36	.04
37	14.27	14.32	14.36	14.41	14.46	14.50	14.55	14.59	14.64	14.68	37	.05
38	14.73	14.78	14.82	14.87	14.91	14.96	15.01	15.05	15.10	15.14	38	.05
39	15.19	15.24	15.28	15.33	15.38	15.42	15.47	15.52	15.56	15.61	39	.05
40	15.66	15.70	15.75	15.80	15.84	15.89	15.94	15.99	16.03	16.08	40	.05
41	16.13	16.18	16.23	16.27	16.32	16.37	16.41	16.46	16.51	16.56	41	.05
42	16.60	16.65	16.70	16.75	16.80	16.84	16.89	16.94	16.99	17.04	42	.05
43	17.09	17.14	17.18	17.23	17.28	17.33	17.38	17.43	17.48	17.53	43	.05
44	17.57	17.62	17.67	17.72	17.77	17.82	17.87	17.92	17.97	18.02	44	.05
45	18.07	18.12	18.17	18.22	18.27	18.32	18.37	18.42	18.47	18.52	45	.05
46	18.57	18.62	18.67	18.72	18.77	18.82	18.87	18.92	18.97	19.02	46	.05
47	19.07	19.12	19.18	19.23	19.28	19.33	19.38	19.43	19.48	19.53	47	.05
48	19.59	19.64	19.69	19.74	19.79	19.84	19.90	19.95	20.00	20.05	48	.05
49	20.10	20.16	20.21	20.26	20.31	20.37	20.42	20.47	20.52	20.58	49	.05
50	20.63	20.68	20.74	20.79	20.84	20.90	20.95	21.00	21.06	21.11	50	.05

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Table II

Four Figure Table for Converting:

(1) Volume Drying Shrinkage (per cent of dry volume) to Linear Drying Shrinkage (per cent of dry length),

(2) Volume Firing Shrinkage (per cent of fired volume) to Linear Firing Shrinkage (per cent of fired length), and

(3) Volume Expansion (per cent of initial volume) to Linear Expansion (per cent of initial length).

Per Cent Volume Change	Per Cent Volume Change											Differences
	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9		
	Per Cent Linear Change											
0	0.000	0.033	0.067	0.100	0.133	0.166	0.200	0.233	0.266	0.299	0	.033
1	0.332	0.365	0.398	0.431	0.464	0.497	0.530	0.563	0.596	0.629	1	.033
2	0.662	0.695	0.728	0.761	0.794	0.826	0.859	0.892	0.925	0.957	2	.033
3	0.990	1.023	1.055	1.088	1.121	1.153	1.186	1.218	1.251	1.283	3	.033
4	1.316	1.348	1.381	1.413	1.446	1.478	1.510	1.543	1.575	1.607	4	.032
5	1.640	1.672	1.704	1.736	1.769	1.801	1.833	1.865	1.897	1.929	5	.032
6	1.961	1.993	2.025	2.057	2.089	2.121	2.153	2.185	2.217	2.249	6	.032
7	2.281	2.313	2.345	2.376	2.408	2.440	2.472	2.503	2.535	2.567	7	.032
8	2.599	2.630	2.662	2.693	2.725	2.757	2.788	2.820	2.851	2.883	8	.032
9	2.914	2.946	2.977	3.009	3.040	3.071	3.103	3.134	3.165	3.196	9	.031
10	3.228	3.259	3.291	3.322	3.353	3.384	3.415	3.446	3.478	3.509	10	.031
11	3.540	3.571	3.602	3.633	3.664	3.695	3.726	3.757	3.788	3.819	11	.031
12	3.850	3 881	3.912	3.943	3.973	4.004	4.035	4.066	4.097	4.127	12	.031
13	4.158	4.189	4.219	4.250	4.281	4.311	4.342	4.373	4.403	4.434	13	.031
14	4.464	4.495	4.525	4.556	4.586	4.617	4.647	4.678	4.708	4.739	14	.030
15	4.769	4.799	4.830	4.860	4.890	4.921	4.951	4.981	5.011	5.042	15	.030
16	5.072	5.102	5.132	5.162	5.192	5.222	5.253	5.283	5.313	5.343	16	.030
17	5.373	5.403	5.433	5.463	5.493	5.523	5.553	5.583	5.612	5.642	17	.030
18	5.672	5.702	5.732	5.762	5.791	5.821	5.851	5.881	5.910	5.940	18	.030
19	5.970	6.000	6.029	6.059	6.088	6.118	6.148	6.177	6.206	6.236	19	.030
20	6.266	6.295	6.325	6.354	6.384	6.413	6.443	6.472	6.501	6.531	20	.029
21	6.560	6.590	6.619	6.648	6.678	6.707	6.736	6.765	6.795	6.824	21	.029
22	6.853	6.882	6.911	6.940	6.970	6.999	7.028	7.057	7.086	7.115	22	.029
23	7.144	7.173	7.202	7.231	7.260	7.289	7.318	7.347	7.376	7.405	23	.029
24	7.434	7.463	7.491	7.520	7.549	7.578	7.607	7.635	7.664	7.693	24	.029
25	7.722	7.750	7.779	7.808	7.836	7.865	7.894	7.922	7.951	7.980	25	.029
26	8.008	8.037	8.065	8.094	8.122	8.151	8.179	8.208	8.236	8.265	26	.028
27	8.293	8.322	8.350	8.378	8.407	8.435	8.463	8.492	8.520	8.548	27	.028
28	8.577	8.605	8.633	8.661	8.690	8.718	8.746	8.774	8.802	8.831	28	.028
29	8.859	8.887	8.915	8.943	8.971	8.999	9.027	9.055	9.083	9.111	29	.028
30	9.139	9.167	9.195	9.223	9.251	9.279	9.307	9.335	9.363	9.391	30	.028
31	9.418	9.446	9.474	9.502	9.530	9.557	9.585	9.613	9.641	9.668	31	.028
32	9.696	9.724	9.751	9.779	9.807	9.834	9.862	9.890	9.917	9.945	32	.027
33	9.972	10.00	10.02	10.05	10.08	10.11	10.14	10.16	10.19	10.22	33	.03
34	10.25	10.27	10.30	10.33	10.36	10.38	10.41	10.44	10.47	10.49	34	.03
35	10.52	10.55	10.58	10.60	10.63	10.66	10.68	10.71	10.74	10.77	35	.03
36	10.79	10.82	10.85	10.87	10.90	10.93	10.96	10.98	11.00	11.03	36	.03
37	11.06	11.09	11.12	11.14	11.17	11.20	11.23	11.25	11.28	11.31	37	.03
38	11.33	11.36	11.39	11.41	11.44	11.47	11.49	11.52	11.55	11.57	38	.03
39	11.60	11.63	11.65	11.68	11.71	11.74	11.76	11.79	11.82	11.84	39	.03
40	11.87	11.90	11.92	11.95	11.98	12.00	12.03	12.05	12.08	12.11	40	.03
41	12.13	12.16	12.19	12.21	12.24	12.27	12.29	12.32	12.35	12.37	41	.03
42	12.40	12.43	12.45	12.48	12.50	12.53	12.56	12.58	12.61	12.64	42	.03
43	12.66	12.69	12.71	12.74	12.77	12.79	12.82	12.85	12.87	12.90	43	.03
44	12.92	12.95	12.98	13.00	13.03	13.05	13.08	13.11	13.13	13.16	44	.03
45	13.19	13.21	13.24	13.26	13.29	13.31	13.34	13.37	13.39	13.42	45	.03
46	13.44	13.47	13.50	13.52	13.55	13.57	13.60	13.62	13.65	13.68	46	.03
47	13.70	13.73	13.75	13.78	13.81	13.83	13.86	13.88	13.91	13.93	47	.03
48	13.96	13.99	14.01	14.04	14.06	14.09	14.11	14.14	14.17	14.19	48	.03
49	14.22	14.24	14.27	14.29	14.32	14.34	14.37	14.39	14.42	14.44	49	.03
50	14.47	14.50	14.52	14.55	14.57	14.60	14.62	14.65	14.67	14.70	50	

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Table III

Four Figure Table for Converting:

(1) Drying Shrinkage (per cent of plastic size) to Drying Shrinkage (per cent of dry size),

(2) Firing Shrinkage (per cent of unfired or dry size) to Firing Shrinkage (per cent of fired size), and

(3) Expansion (per cent of final size) to Expansion (per cent of initial size).

Unconverted Percentage	Unconverted Percentage	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	Unconverted Percentage	Differences
		Converted Percentage											
	0	0.00	0.100	0.200	0.301	0.402	0.503	0.604	0.705	0.806	0.908	0	.101
	1	1.010	1.112	1.215	1.317	1.420	1.523	1.626	1.729	1.833	1.937	1	.103
	2	2.041	2.145	2.249	2.354	2.459	2.564	2.670	2.775	2.881	2.987	2	.105
	3	3.093	3.199	3.306	3.413	3.520	3.627	3.734	3.842	3.950	4.058	3	.107
	4	4.167	4.275	4.384	4.493	4.603	4.712	4.822	4.932	5.042	5.152	4	.110
	5	5.263	5.374	5.485	5.597	5.708	5.820	5.932	6.045	6.157	6.270	5	.112
	6	6.383	6.496	6.610	6.724	6.838	6.952	7.066	7.181	7.296	7.411	6	.114
	7	7.527	7.643	7.759	7.875	7.991	8.108	8.225	8.342	8.460	8.578	7	.117
	8	8.696	8.814	8.932	9.051	9.170	9.290	9.409	9.529	9.649	9.769	8	.119
	9	9.890	10.01	10.13	10.25	10.38	10.50	10.62	10.74	10.86	10.99	9	.12
	10	11.11	11.23	11.36	11.48	11.61	11.73	11.86	11.98	12.11	12.23	10	.12
	11	12.36	12.49	12.61	12.74	12.87	12.99	13.12	13.25	13.38	13.51	11	.13
	12	13.64	13.77	13.90	14.03	14.16	14.29	14.42	14.55	14.68	14.81	12	.13
	13	14.94	15.07	15.21	15.34	15.47	15.61	15.74	15.87	16.01	16.14	13	.13
	14	16.28	16.41	16.55	16.69	16.82	16.96	17.10	17.23	17.37	17.51	14	.14
	15	17.65	17.79	17.92	18.06	18.20	18.34	18.48	18.62	18.76	18.91	15	.14
	16	19.05	19.19	19.33	19.47	19.62	19.76	19.90	20.05	20.19	20.34	16	.14
	17	20.48	20.63	20.77	20.92	21.07	21.21	21.36	21.51	21.65	21.80	17	.15
	18	21.95	22.10	22.25	22.40	22.55	22.70	22.85	23.00	23.15	23.30	18	.15
	19	23.46	23.61	23 76	23.92	24.07	24.22	24.38	24.53	24.69	24.84	19	.15
	20	25.00	25.16	25.31	25.47	25.63	25.79	25.94	26.10	26.26	26.42	20	.16
	21	26.58	26.74	26.90	27.06	27.23	27.39	27.55	27.71	27.88	28.04	21	.16
	22	28.21	28.37	28.53	28.70	28.87	29.03	29 20	29.37	29.53	29.70	22	.17
	23	29.87	30.04	30.21	30.38	30.55	30.72	30.89	31.06	31.23	31.41	23	.17
	24	31.58	31.75	31.93	32.10	32.28	32.45	32.63	32.80	32.98	33.16	24	.18
	25	33.33	33.51	33.69	33.87	34.05	34.23	34.41	34.59	34.77	34.95	25	.18
	26	35.14	35.32	35.50	35.69	35.87	36.05	36.24	36.43	36.61	36.80	26	.19
	27	36.99	37.17	37.36	37.55	37.74	37.93	38.12	38.31	38.50	38.70	27	.19
	28	38.89	39.08	39.28	39.47	39.66	39.86	40.06	40.25	40.45	40.65	28	.20
	29	40.85	41.04	41.24	41.44	41.64	41.84	42.05	42.25	42.45	42.65	29	.20
	30	42.86	43.06	43.27	43.47	43.68	43.88	44.09	44.30	44.51	44.72	30	.21
	31	44.93	45.14	45.35	45.56	45.77	45.99	46.20	46.41	46.63	46.84	31	.21
	32	47.06	47.28	47.49	47.71	47.93	48.15	48.37	48.59	48.81	49.03	32	.22
	33	49.25	49.48	49.70	49.93	50.15	50.38	50.60	50.83	51.06	51.29	33	.23
	34	51.52	51.75	51.98	52.21	52.44	52.67	52.91	53.14	53.37	53.61	34	.23
	35	53.85	54.08	54.32	54.56	54.80	55.04	55.28	55.52	55.76	56.01	35	.24
	36	56.25	56.49	56.74	56.99	57.23	57.48	57.73	57.98	58.23	58.48	36	.25
	37	58.73	58.98	59.24	59.49	59.74	60.00	60.26	60.51	60.77	61.03	37	.26
	38	61.29	61.55	61.81	62.07	62 34	62.60	62.87	63.13	63.40	63.67	38	.26
	39	63.93	64.20	64.47	64.74	65.02	65.29	65.56	65.84	66.11	66.39	39	.27
	40	66.67	66.94	67.22	67.50	67.79	68.07	68.35	68.63	68.92	69.20	40	.28
	41	69.49	69.78	70.07	70.36	70.65	70.94	71.23	71.53	71.82	72.12	41	.29
	42	72.41	72.71	73.01	73.31	73.61	73.91	74.22	74.52	74.83	75.13	42	.30
	43	75.44	75.75	76.06	76.37	76.68	76.99	77.30	77.62	77.94	78.25	43	.31
	44	78.57	78.89	79.21	79.53	79.86	80.18	80.51	80.83	81.16	81.49	44	.32
	45	81.82	82.15	82.48	82.82	83.15	83.49	83.82	84.16	84.50	84.84	45	.34
	46	85.19	85.53	85.87	86.22	86.57	86.92	87.27	87.62	87.97	88 32	46	.35
	47	88.68	89 04	89.39	89.75	90.11	90.48	90.84	91.20	91.57	91.94	47	.36
	48	92.31	92.68	93.05	93.42	93.80	94.17	94.55	94.93	95.31	95.69	48	.38
	49	96.08	96.46	96.85	97.24	97.63	98.02	98.41	98.81	99.20	99.60	49	.39
	50	100.0	100.4	100.8	101.2	101.6	102.0	102.4	102.8	103.3	103.7	50	.4

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Table IV

Four Figure Table for Converting:

(1) Drying Shrinkage (per cent of dry size) to Drying Shrinkage (per cent of plastic size),

(2) Firing Shrinkage (per cent of fired size) to Firing Shrinkage (per cent of unfired or dry size), and

(3) Expansion (per cent of initial size) to Expansion (per cent of final size).

Unconverted Percentage	Unconverted Percentage											Differences
	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9		
	Converted Percentage											
0	0.000	0.100	0.200	0.299	0.398	0.498	0.596	0.695	0.794	0.892	0	.099
1	0.990	1.088	1.186	1.283	1.381	1.478	1.575	1.672	1.768	1.865	1	.097
2	1.961	2.057	2.153	2.248	2.344	2.439	2.534	2.629	2.724	2.818	2	.095
3	2.913	3.007	3.101	3.195	3.288	3.382	3.475	3.568	3.661	3.754	3	.093
4	3.846	3.939	4.031	4.123	4.215	4.306	4.398	4.489	4.580	4.671	4	.091
5	4.762	4.853	4.943	5.033	5.123	5.213	5.303	5.393	5.482	5.571	5	.090
6	5.660	5.749	5.838	5.927	6.015	6.103	6.191	6.279	6.367	6.455	6	.088
7	6.542	6.629	6.716	6.803	6.890	6.977	7.063	7.149	7.236	7.322	7	.087
8	7.407	7.493	7.579	7.664	7.749	7.834	7.919	8.004	8.088	8.173	8	.085
9	8.257	8.341	8.425	8.509	8.592	8.676	8.759	8.842	8.925	9.008	9	.083
10	9.091	9.173	9.256	9.338	9.420	9.502	9.584	9.666	9.747	9.829	10	.082
11	9.910	9.991	10.07	10.15	10.23	10.31	10.39	10.47	10.55	10.63	11	.08
12	10.71	10.79	10.87	10.95	11.03	11.11	11.19	11.27	11.35	11.43	12	.08
13	11.50	11.58	11.66	11.74	11.92	11.89	11.97	12.05	12.13	12.20	13	.08
14	12.28	12.36	12.43	12.51	12.59	12.66	12.74	12.82	12.89	12.97	14	.08
15	13.04	13.12	13.19	13.27	13.34	13.42	13.49	13.57	13.64	13.72	15	.08
16	13.79	13.87	13.94	14.02	14.09	14.16	14.24	14.31	14.38	14.46	16	.07
17	14.53	14.60	14.68	14.75	14.82	14.89	14.97	15.04	15.11	15.18	17	.07
18	15.25	15.33	15.40	15.47	15.54	15.61	15.68	15.75	15.82	15.90	18	.07
19	15.97	16.04	16.11	16.18	16.25	16.32	16.39	16.46	16.53	16.60	19	.07
20	16.67	16.74	16.81	16.87	16.94	17.01	17.08	17.15	17.22	17.29	20	.07
21	17.36	17.42	17.49	17.56	17.63	17.70	17.76	17.83	17.90	17.97	21	.07
22	18.03	18.10	18.17	18.23	18.30	18.37	18.43	18.50	18.57	18.63	22	.07
23	18.70	18.76	18.83	18.90	18.96	19.03	19.09	19.16	19.22	19.29	23	.07
24	19.35	19.42	19.48	19.55	19.61	19.68	19.74	19.81	19.87	19.94	24	.06
25	20.00	20.06	20.13	20.19	20.26	20.32	20.38	20.45	20.51	20.57	25	.06
26	20.63	20.70	20.76	20.82	20.89	20.95	21.01	21.07	21.14	21.20	26	.06
27	21.26	21.32	21.38	21.45	21.51	21.57	21.63	21.69	21.75	21.81	27	.06
28	21.87	21.94	22.00	22.06	22.12	22.18	22.24	22.30	22.36	22.42	28	.06
29	22.48	22.54	22.60	22.66	22.72	22.78	22.84	22.90	22.96	23.02	29	.06
30	23.08	23.14	23.20	23.25	23.31	23.37	23.43	23.49	23.55	23.61	30	.06
31	23.66	23.72	23.78	23.84	23.90	23.95	24.01	24.07	24.13	24.18	31	.06
32	24.24	24.30	24.36	24.41	24.47	24.53	24.59	24.64	24.70	24.76	32	.06
33	24.81	24.87	24.92	24.98	25.04	25.09	25.15	25.21	25.26	25.32	33	.06
34	25.37	25.43	25.48	25.54	25.60	25.65	25.71	25.76	25.82	25.87	34	.06
35	25.93	25.98	26.04	26.09	26.14	26.20	26.25	26.31	26.36	26.42	35	.05
36	26.47	26.52	26.58	26.63	26.69	26.74	26.79	26.85	26.90	26.95	36	.05
37	27.01	27.06	27.11	27.17	27.22	27.27	27.33	27.38	27.43	27.48	37	.05
38	27.54	27.59	27.64	27.69	27.75	27.80	27.85	27.90	27.95	28.01	38	.05
39	28.06	28.11	28.16	28.21	28.26	28.32	28.37	28.42	28.47	28.52	39	.05
40	28.57	28.62	28.67	28.72	28.77	28.83	28.88	28.93	28.98	29.03	40	.05
41	29.08	29.13	29.18	29.23	29.28	29.33	29.38	29.43	29.48	29.53	41	.05
42	29.58	29.63	29.68	29.73	29.78	29.82	29.87	29.92	29.97	30.02	42	.05
43	30.07	30.12	30.17	30.22	30.26	30.31	30.36	30.41	30.46	30.51	43	.05
44	30.56	30.60	30.65	30.70	30.75	30.80	30.84	30.89	30.94	30.99	44	.05
45	31.03	31.08	31.13	31.18	31.22	31.27	31.32	31.37	31.41	31.46	45	.05
46	31.51	31.55	31.60	31.65	31.69	31.74	31.79	31.83	31.88	31.93	46	.05
47	31.97	32.02	32.07	32.11	32.16	32.20	32.25	32.30	32.34	32.39	47	.05
48	32.43	32.48	32.52	32.57	32.61	32.66	32.71	32.75	32.80	32.84	48	.05
49	32.89	32.93	32.98	33.02	33.07	33.11	33.16	33.20	33.24	33.29	49	.04
50	33.33	33.38	33.42	33.47	33.51	33.55	33.60	33.64	33.69	33.73	50	.04

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Tables Four figure computing tables which can be used to avoid the calculations involved in the use of the equations of groups 1 and 2 of the foregoing section are given at the end of the paper.

Examples Examples showing the use of the tables and equations have been given.

Appendix

Algebraic Interpretation Equations (4), (6), and (12), Tables B and D, can be used to replace equations (4) to (7) and (12) to (13) inclusive if substitutions are made and results are interpreted algebraically and a convention of signs is adopted. The following conventions may be used:

(1) All percentages in one equation should be based on initial values or all should be based on final values.

(2) When percentages are based on initial values, consider expansions to be positive and contractions to be negative.

(3) When percentages are based on final values, consider expansions to be negative and contractions positive.

Other Applications Tables III and IV and the equations given in Tables C and D may be used in interest and discount calculations and in combining per cent loss on drying and per cent loss on ignition in calculations based on chemical analyses.

Acknowledgment The writer wishes to express his appreciation of the interest and help of C. W. Parmelee, Head of the Department of Ceramic Engineering, University of Illinois, and of J. B. Christensen, Jr., who assisted with the arithmetical computation required in connection with the tables.

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Vol. 7 | September, 1928 | No. 9

Author Index to Ceramic Abstracts for September[1]

AUTHOR	PAGE
A. E.	598
Ackermann, H. and Langenheim, W.	629
Alison, A.	606
Allen, C. M.	645
Azbe, V. J.	594
Banner, G. A.	589
Bartell, F. E.	641
Barth, T.	643
Bates, P. H.	597
Baum, F.	633
Bennion, F., Plant, H. J., and Clarke, J. B.	636
Berger, E.	605
Besombe, A.	643
Blank, A. J.	594
Blaschke, M.	594
Bogue, R. H.	594
Bole, G. A. and Nold, H. E.	615
Bolyea, B.	590
Bonini, C. F.	651
Booze, M. C.	620, 621
Bott, L. P., Jr.	593
Bouyoucos, G. J.	641
Bowen, C. A.	646
Bowles, O.	622, 637
Bradbury, R. H.	645
Breuil, P.	628
Brit. Hartford-Fairmont Synd., Ltd.	613
British Thomson-Houston Co., Ltd.	614
Brown, D.	615
Buckley, F.	606
Budnikoff, P. P.	595
Bujor, D. I.	596
Burbidge, P. W. and Alexander, N. S.	629
Burkhalter, E.	615
Burrell, G. A.	634
Campbell, J. R.	632
Carr, A. R. and Rente, A. M.	639
Carty, E. F.	606
Chapman, S.	636
Chappell, E. L., Roetheli, B.E., and McCarthy, B. Y.	598
Cohn, W. M.	607, 640
Cole, L. H.	637, 638
Conniff, P. H.	622
Conquest Mill Eng. Co., Ltd.	627
deCoriolis, E. G.	648
Cornwell, V. O.	611
Coulhon, A. J.	636
Couture, M.	634
Cox, P. E.	592
Cox, W. and Shuman, A.	612
Crouch, W. D.	627
Crowe, P. L.	629
Crowell, W. S.	596
Curtis, T. S.	638
Daniels, F.	639
Daniels, F. H.	648
Danner, E.	610
Davis, H. E.	623
De Carli, F.	642
Demarest, F. C.	649
Demuth, W.	626
De Renzis, G.	613
Desch, C. H.	640
Diamond, G. S.	622
Diepschlag, E. and Fliegenschmidt, H.	639
Dietrich, W. F.	652
Dimbleby, V.	609
Dittlinger, H.	597
Dominikiewicz, M.	637
Donath, E.	624
Dovel, J. P.	622
Dunn, F. B.	617
Dunn, P. H. H.	648
Dunwoody, W. E.	646
Dyckerhoff, W.	596
Dyer, W. A.	624
E. B. P.	650
Eckert, E. and Zschacke, F. H.	607
Eley, C. V. A.	636
English, S.	606
Evans, A. E.	612
Feisner, E.	605
Fiske, G. M.	616
Fosdick, M. L.	592
Frazier, C. E.	630
Frechette, H. and Phillips, J. G.	638
Friz, O.	595
Fuller, C. E.	636
Furnas, C. C. and Brown, G. G.	638
Gangwere, R. C.	615
Garner, G.	649
Garve, T. W.	616
General Electric Co., Ltd.	613
Geschwind, L.	617
Gibson, W. A. and Burke, J. G.	629
Gilard, P.	609
Gold, A. K.	598
Goslich, K.	596
Green, A. T.	622
Grenet, L.	598
Grün	595
H. A.	627
H. T. U. R.	651
Hackford, J. E.	636
Hahn, C.	635
Hamilton, W. C.	651
Hammer, J. M.	600

[1]The abbreviation (*C.A.*) at the end of an abstract indicates that it was obtained from *Chemical Abstracts* by coöperative agreement.

AUTHOR	PAGE
Handrek, H.	624
Hansen, J. E.	599
Hanson, B. M. W.	592
Harkort, H.	625
Harrison, W. N., Saeger, C. M., Jr., and Krynitsky, A. I.	597
Harvey, G. H.	612
Hayden, A.	593
Heckert, S. F.	615
Heinrichs, H.	604
Heuze, C.	611
Hill, E. C.	624
Hirsch, H.	620
Hitchcock, H. K.	600
Hochstein, L.	612
Hofmann, F. H.	593
Hohnhorst, F. J.	591
Hole, E.	618
Hughes, W. T.	609
Hursh, R. K. and Mills, R. G.	645
Irwin, D. K.	601
Jacks, G. V.	637
Jacobs, F. B.	590
Jander, W.	644
Jasper, T. M.	598
Jewell, L. E.	628
Johanson, P. and Webster, D. E.	591
Jordan, C. J.	613
Joseph, T. L.	594
Karsten, A.	628
Keller, J. D.	618
Keller, J. R.	611
Keppeler, G.	604
King, R. M.	649
Kingsbury, P. C.	649
Kleinmann, H.	643
Kleymeyer, H. C.	646
Kline, A. L. and Clark, C. F.	591
Kniepert, K.	623
Koch, W. C.	618
Köhler, W.	639
Koppers, H.	635
Krak, J. B.	602
Kühl, Hans	596
Kühl, Hugo	609
Kuhn, A.	630
Künzel, K.	612
Laboratoire De Perfectionnements Thermiques	623
Larcheveque, M.	627
Larsen, B. M.	619
Lawton, G. O., Dowthwaite, S., and Albion Clay Co., Ltd.	618
Lennard-Jones, J. E. and Dent, B. M.	641
Lipinski, Fr.	628
Longenecker, L. S.	619
Lovernug, E. G.	627
Ludwig, K.	649
Lytle, C. W.	645
Mabee, G. E.	639
Macaulay, J. M.	641
Mailey, R. D. and Winninghoff, W. J.	612
Mallabar, H. J. and Non-Inflammable Film Co., Ltd.	614
Mambourg, N.	610
Martin, L. C.	608
Mauri, A.	608
Mavor, W.	598
May, W. J.	621
Mazzucchelli, A. and Romani, B.	643
McBain, J. W.	616
McMillan, F. R.	597
McQueen, H. S. and Forbes, C. R.	637
Melzer, H.	599
Middendorf, D. L.	611
Millar, G. A.	612
Miller, J. R.	619
Minsky, L.	606
Mitchell, W. B.	620
Morris, G. D.	635
Morton, W. A.	600
Mulligan, M. J. and Ferguson, J. B.	609
Neumann, B.	610
Norton, C. H.	591
Oakley, W. A.	597
Oeffner, A. A.	630
"Osa" Participations Industrielles Soc. Anon.	615
Parr, S. W. and Straub, F. G.	648
Parravano, N. and Malquori, G.	641
Pearson, B. M.	592, 599, 601
Peiler, K. E.	611
Peir, H. M.	634
Pinte, J.	594
Pioda, L. E. W.	629
Pirrone, A. L. M.	610
Platzmann, C. R.	594
Pletcher, F. B.	589
Power, W. P. and Lewis, E.	622
Prouty, T. C. and W. O.	627, 630, 635
Quartz et Silice	623
Rankin, C. H.	614
Rao, T. V. M.	637
Ray, K. W. and Mathers, F. C.	638
von Reiche, L. and Giersbach, J.	616
Reiter, F. M.	632
Reviere, G. H.	593
Rhead, F. H.	624
Rhodes, W. H.	589
Rice, W. E.	633
Richards, C. W.	616
Rieke, R.	625
Rieke, R. and Mauve, L.	626
Rieke, R. and Wiese, O.	625
Riemer	616
Robinson, G. W.	637
Rosbaud, P.	603
Rosencrants, F. H.	649
Salmang, H.	609
Schaller, W. T.	637
Schefold, M.	593
Schmidt, H. F.	590
Schmunk, C. E.	611
Schneider, M.	626
Schönborn, H.	606
Schuen, W.	640
Scott, A.	626
Showers, L.	612
Simonds, F. M.	629
Singer, F.	621
Smith, W.	651
Snyder, W. B.	590
Solon, M.	624
Soubier, L. D.	610
Sozzetti, G.	640
Spinasse, A. E.	610
Springer, L.	604
Stang	607
St. John, H. M.	619
Steger, W.	625, 628, 632
Stoddard, R. P.	646
Stöhr, F.	622
Straight, H. R.	635
Strauss, K.	593
Ströder, E.	635
Strong, K. B. and Brauner, E. R.	597
Stümbke, H.	634
Sultzer, N. W.	632
Swain, R. E.	602
Swift, A. H.	639
Tailby, R. V.	592
Taylor, J.	608
Taylor, W. H. and Jackson, W. W.	640
Taylor, W. H. and West, J.	639
Terman, M. J.	619
Thermal Engineering Corp.	614
Thews, E. R.	622

AUTHOR	PAGE
Thor, V. P.	649
Thorpe, W. A.	594
Thurner, A.	644
Tilton, L. W., Finn, A. N., and Tool, A. Q.	605
Tokody, L.	645
Trapp	620
Travers, M. W.	634
Treiber, O. D.	651
Twells, R.	624
United Glass Bottle Mfrs., Ltd., Pryor, E. A. C., and Hurlbut, F. A.	614
Van der Kloes, J. A.	615
Van Schoick, E. H.	649
Ver. f. Chem. & Met. Prod.	623
Vickers, Ltd., and Parker, L. D.	636
Wagner, K.	626
Wasilewski, L.	644
Watson, F. J.	609
Welden, F. H.	589
Westbrook, F. A.	616
Westman, A. E. R.	618
White, W. P.	629
Williams, M. L.	591
Williamson, J.	636
Winchell, A. N.	645
Wirth	628
Withers, J. S.	623
Woodward, W. E.	598
Woolley, C. L.	593
Worker, J. G.	632
Wright, W. D.	593
Wünsch, G.	634

Abrasives

Disk grinders prove economical. FRED B. PLETCHER. *Abrasive Ind.*, 9 [4], 91–94 (1928).—Surface grinding and disk grinding have supplanted many operations that formerly were handled by milling machines and planers. It has been demonstrated in actual shop practice in the past few years that in flat surface operations in many cases, grinding machines have effected real savings over standard types of machining methods. Vitreous china can be machined only by grinding. Another example of nonmetallic grinding is the operation of grinding six faces of insulating brick. The grinding machine is a special and unusual installation, accommodating bricks measuring $2\frac{1}{2}$ by 4 by 9 inches, and producing over 25 bricks a minute. E.P.R.

Silverware polishing methods. GEORGE A. BANNER. *Abrasive Ind.*, 9 [4], 98–99 (1928).—The various means which are employed for polishing gold and silver, practical details, and the necessity of careful polishing before plating, are discussed. E.P.R.

Grinding concrete. ANON. *Abrasive Ind.*, 9 [4], 99 (1928).—Abrasive equipment is coming into general use for removing mold marks and other irregularities from cement work. Water is brushed on the surface before grinding when a fine finish is wanted. Grinding wheels are also used to impart a pebble finish. E.P.R.

Synthetic diamonds. ANON. *Abrasive Ind.*, 9 [4], 101 (1928).—James Basset, a French engineer, claims to have devised a machine capable of applying a pressure of 25 T. per sq. cm. to an electric crucible in which the temperature can be raised to 3500°. These are the conditions which engineers have long contended would produce the synthetic diamond. E.P.R.

Silicate grinding wheel and its inventor, Gilbert Hart. FRANK H. WELDEN. *Abrasive Ind.*, 9 [5], 127–28 (1928).—Facts about the early development of the grinding wheel industry are given. H. worked against strong opposition in introducing his product. The wire web, which is in use today furthered the grinding wheel industry to a greater extent than we realize as it represented the initial safety feature in abrasive engineering practice. E.P.R.

Salvaging of waste abrasive grit. W. H. RHODES. *Abrasive Ind.*, 9 [5], 136 (1928). —The article discusses the possibilities of salvaging waste grit, but up to the present time no use has been found for it, except in making floors. R. made use of old stubs by breaking them up along with old brick and mixing with cement and sand to form concrete for machine foundations. This combination will stand the test of severe vibration. E.P.R.

Diamond data. ANON. *Abrasive Ind.*, 9 [5], 142 (1928).—Polished diamonds are by far the heaviest item of export from Belgium to the U. S. The rough diamonds are all obtained from the diamond syndicate at London, for both the Antwerp and Amsterdam markets. E.P.R.

Simplify coated abrasive products. ANON. *Abrasive Ind.*, 9 [5], 142 (1928).—A general conference of consumers, technical experts, distributers, and manufacturers of

coated abrasive products was held in the Department of Commerce building, Washington, by the Division of Simplified Practice, Department of Commerce, on April 11. The object of the conference was to consider the drafting of a simplified practice recommendation for abrasive paper and cloth. E.P.R.

Abrasive engineering progress. ANON. *Abrasive Ind.*, **9** [5], 148 (1928).—An improved circular relief cutter and reamer, a self-contained belt sander, a belt sander which finishes scroll work, large size micrometer design, and truing centerless grinder wheels by a mechanical dresser are described. E.P.R.

Modern abrasive wheels. FRED B. JACOBS. *Abrasive Ind.*, **9** [6], 151 (1928).—The replacing of grindstones in a midwestern cutlery factory is discussed. E.P.R.

Abrasive men hold conference. ANON. *Abrasive Ind.*, **9** [6], 157 (1928).—A general convention was held in Washington, April 11. E.P.R.

Suggested specifications for purchasing grinding wheels. H. F. SCHMIDT. *Abrasive Ind.*, **9** [6], 158–59 (1928).—The specifications are as follows: measurements are outside diameter, width, bore. The dimensions of grain, G, are called according to the meshes in 1 cm. of a sieve that lets the grain pass through. The shape of the grain shall be nearly equal all around. Slivers and splinters should be discarded. The hardness, H, of the grain is the 100th part of the breaking load of 100 spherical ground grains between plates of hardened tool-steel. The setting of the grains, S, in mm. must be at least 11 G, but may not exceed 15 G. In compound wheels S may be up to 20 G. The strength of the bond, B, may be measured by the breaking load of a test-piece of 1-cm. cross-section, laid on 2 supports 3 cm. apart. The planes of cleavage must go through the bond only and not more than 10 G^2 grains should be broken. At the points of pressure are steel blades held in slots of 1-mm. width protruding 1 mm. Every wheel should be subjected to speed test of at least double the working speed. E.P.R.

Modern grinding wheels. B. BOLYEA. *Abrasive Ind.*, **9** [6] 166–67 (1928).—Grinding is a manufacturing operation, producing work faster, better, and cheaper. Grindstones closely resembling the natural sandstone were made years ago by Ransome's process. The manufacture of wheels is a scientific procedure. They are manufactured in numerous shapes and sizes, to suit all classes of grinding machinery. The size of abrasive grain used determines the degree of coarseness or fineness of a wheel. On the grit depends the cutting action, and the bonding material used determines the grade of hardness. Grade refers to the resistance of the cutting particles under pressure. If the cutting points are easily broken the wheel is soft, while a wheel that retains its particles longer is called hard. The ideal wheel for any class of work is one that provides a new cutting face as fast as the points in use become dull as the proper wheel will not glaze, but will remain sharp. There are five processes used in making wheels: vitrified, silicate, shellac, rubber, and bakelite. The greater number of wheels are vitrified. It produces an open porous texture, which insures fast free-cutting action. They are not affected by weather, time, water, oils, acids, or soda and are used for both dry and wet grinding. Fusible clays (feldspars) fired in a high temperature vitrifying kiln consist of the bonding material. To form wheels by this process two distinct methods are used, puddling and pressing. E.P.R.

Test abrasives. ANON. *Abrasive Ind.*, **9** [7], 195 (1928).—One of the many interesting and educational exhibits at the recent foundry convention held at Philadelphia was that of the American Steel Abrasive Co., Galion, Ohio, where a special Tinius-Olsen shot testing machine was shown. E.P.R.

PATENTS

Cylinder-grinding machine. WILLIAM B. SNYDER. U. S. 1,673,924, June 19, 1928. A tool of the character described including a body member, an abrasive element extending longitudinally of the body member and of a length greater than the piston stroke of the

motor the cylinder of which is to be re-ground, means for normally influencing the abrasive element outwardly of the body portion, and means on the body portion to prevent tilting of the body portion as it is applied to or removed from a cylinder to protect the abrasive elements against being broken by engagement with the edges of the cylinder.

Grinding machine. MARTIN L. WILLIAMS. U. S. 1,674,672, June 26, 1928. In a grinding machine, the combination with a frame having vertical supporting columns with a central longitudinal opening, of a head having mounted thereon an arbor enclosing a grinding wheel spindle, a mechanism for producing vertical reciprocation of the head, a motor mounted on the head for driving the respective mechanisms, the head and its elements reciprocating as a unit, eccentric means manually set and automatically operated for giving the axis of the grinding wheel spindle a rotative movement during the vertical reciprocation of the head.

Grinding machine. MARTIN L. WILLIAMS. U. S. 1,674,673, June 26, 1928. In a grinding machine having vertical columns and an open passageway therebetween, the combination with a reciprocating head mounted between the columns, of a grinding spindle positioned within eccentric sleeves, and a motor for driving the spindle mounted upon the head, a hydraulic ram attached to the head and automatically operated to lower and raise the head during the grinding operation.

Grinding machine. ARTHUR L. KLINE AND CHARLES F. CLARK. U. S. 1,674,973, June 26, 1928. The combination in a machine having a work supporting platen adapted for motion in a horizontal plane, of means to move one point of the platen in a circular path in the plane, and means to maintain the platen parallel to a given line in the plane, the means including a floating member and two pairs of parallel links normally disposed relative to each other and the pairs pivotally connected respectively to the member and a fixed support and to the platen and member.

Abrading nib for abrading machines. FERDINAND J. HOHNHORST. U. S. 1,675,804, July 3, 1928. A rotatable abrading nib for coaction with the grinding face of a grinding wheel, the rotatable abrading nib having an end-contact abrading face and holes in the end-contact abrading face at different radial distances from the axis of rotation of the rotatable abrading nib movable in circles of different diameters across the grinding face of the grinding wheel.

Rubber-bonded abrasive wheel. PEHR JOHANSON AND DUANE E. WEBSTER. U. S. 1,676,190, July 3, 1928. The improvement in the manufacture of rubber bonded abrasive articles, such as grinding wheels, which comprises incorporating in the rubber bond a wax in an amount sufficient to modify the properties of the vulcanized rubber bond and decrease the hardness of the bonded article.

Grinding apparatus. CHARLES H. NORTON. U. S. 1,676,620, July 10, 1928. In apparatus of the character described, in combination, a grinding throat adapted for simultaneous grinding and rotating action upon work of round section and comprising three means: (1) in the form of a grinding wheel adapted to be rotated at a relatively high speed, (2) in the form of a regulating wheel adapted to be rotated at a relatively low speed and in a direction to present an operative surface traveling in a direction opposite from that of the adjacent grinding wheel surface and adapted thereby to control the rotation of the work, and (3) includes a member for holding work of round section in operative relation to the two wheels, each of the means being shaped to present a line of contact to work of round section and the three means being related one to the other so that the lines of contact presented thereby to the work form elements of a frustrum of a cone; and means for moving a work piece into and through the grinding throat and in a direction from the larger end of the grinding throat to the smaller end thereof, thereby progressively to grind a frusto-conical surface from one end of the work to the other and to reduce the work piece to a diameter equal to that of the smaller end of the frustrum.

Grinding machine. BENGT M. W. HANSON. U. S. 1,676,643, July 10, 1928. In a thread grinding machine, a grinding wheel having a plurality of circumferential grinding edges or serrations, means for rotating the wheel, a work holder including a work spindle and mounted for movement axially of the spindle, a rotary shaft; a cam thereon connected to the work holder and having a cam portion for moving the holder on its operative stroke in accordance with the pitch of the thread operated upon and a cam portion for returning the work holder on its inoperative stroke; means for rotating the work spindle and gearing between the work spindle and shaft whereby the cam makes one revolution in moving the work holder on its operative and inoperative strokes while the work spindle is rotating more than one revolution.

Art

Kilns, furnaces, bodies, and glazes for small commercial production and educational work. PAUL E. COX. *Jour. Amer. Ceram. Soc.*, **11** [8], 649-57 (1928).—Drawings and specifications for two small commercial kilns, one small test kiln, and a frit furnace are shown. Glazes suitable for use in the kilns are described. Shales and No. 2 fire clay are suggested for use. Reference is made to wares of commercial quality now being made in kilns of the kind indicated. Two sorts of copper red glazes are discussed and reference is made to the use of salt in effecting changes in the character of glazes. Fritted mat glazes are discussed and endorsed as superior to the raw sort, because of greater flexibility. A kiln atmosphere charged with vapors of common salt effects interesting changes in both the character of glazes and the usual colors produced by the commonly used oxides. A normally glossy, bright, and clear glaze becomes a vellum-like mat when fired in the presence of NaCl under certain conditions. A positive method of producing low-fired copper reds and lusters is described.

The problem of printed tableware. MARION L. FOSDICK. *Bull. Amer. Ceram. Soc.*, **7** [7], 171–73 (1928).—American tableware is censured for its lack of interest from an artistic viewpoint. This would not be so severe if it were fully realized what difficulties have already been overcome in tableware factories. The making of decalcomania is described. This process is such that only a few manufacturers can make their own decalcomania, as it requires an added overhead of skilled workmen and perfection in control required by materials and surroundings. The charm of table decoration lies not only in its intrinsic beauty but in its interest relative to its surroundings, and this presents a technical problem of manufacture to be solved by study and practice. E.J.V.

Acid-resisting overglaze colors. R. V. TAILBY. *Pottery Gaz.*, **53** [613], 1114 (1928); reprinted from *Jour. Amer. Ceram. Soc.*, **11** [5], 307–309 (1928); see also *Ceram. Abs.*, **7** [6], 342 (1928). E.J.V.

Electric firing and stained glass. B. M. PEARSON. *Ceram. Age*, **11** [6], 214–20 (1928).—After briefly outlining the difference between the work of modern and ancient stained glass artists, P. lists the requirements of a furnace for making stained glass. These include a clean furnace atmosphere and accurate temperature control, the former so as to secure accurate colors and the latter to prevent distortion and rounding of the pieces and so enable accurate window building and also to enable special effects to be secured by different degrees of fusion. An electric kiln specially designed for the work of stained glass artists which has been operated successfully in the Nicholson works in England is then described in detail. It replaced a gas-fired furnace. The ware is fired on trays made of a composition containing 50% bonded asbestos held in a skeleton iron framework. Sheet-iron trays were unsatisfactory due to their high specific heat and thermal conductivity, and their tendency to scale and oxidize. The furnace is nichrome wound, special chambers being provided for heating and cooling. A silver

fuse is used to prevent excessive temperatures. A temperature control of 5°C with a time lag of 20 minutes is obtained. The kiln provides efficient heat control, a pure atmosphere, rapid heating, economy in firing, pleasant working conditions, and does not cause scumming due to deposition of moisture, a defect of the gas-fired furnace. The character of the work made in the plant is described. A detailed discussion of medieval stained glass and of the early production of colors is given. A.E.R.W.

Niloak pottery, Benton, Arkansas. L. P. Bott, Jr. *Ceram. Age*, **6** [11], 219–20 (1928).—B. describes the development, raw materials, method of manufacture and finished products of the Niloak Pottery. Color effects are obtained by blending natural kaolins. A.E.R.W.

Porcelain collections of the Munich Palace-museum. Friedrich H. Hofmann. *Keram. Rund.*, **36,** 270–77 (1928).—Porcelains formerly in the possession of Bavarian princes and now collected in the Palace-museum are described. Pieces date from the late 17th Century. (Illustrated.) H. I.

The works of Olga Daiber of Ulm. Max Schefold. *Keram. Rund.*, **36,** 293–95 (1928).—A short description of the life and technique of this ceramic artist is given with photographs of her products. H.I.

La Pottery Precolombienne. Georges-Henri Reviere. *Art et Dec.*, May, 141–48 (1928).—Illustrated description of South American potteries including Mayan, Pueblos, Yucatan, Cheapas, Tobasco, Honduras, Guatamala, and Salvador. Incising, pressing, modeling, molding, painting on clay, setting in insets were methods used to portray the civilization of the countries; the wheel was unknown. Shallow three-legged bowls, grotesque animal shapes, modeled vases with glyphes, funeral urns, flat baths, whistles, anthromomorphic shapes are in the collection, as well as some polychrome glazes, painted in red, black and white. Venezuela was known for its statuettes. The collection can be seen at the Pavillion de Marjan. M.G.W.

Old Silesian potters art. Konrad Strauss. *Sprechsaal*, **61** [6], 101–103 (1928).—The potters' art from the 12th to 19th centuries is discussed and illustrated. R.A.H.

A trichromatic colorimeter. W. D. Wright. *Chem. and Ind.*, **47,** 672 (1928).—The standard colors used are the primaries of the spectrum. Two spectra are formed from the same source of light: one of the colors to be tested (together with a desaturating color), the other a mixture of the primaries. The beams are brought into the two halves of a simple bipartite field for comparison. The instrument has devices for removing stray light, and for making observations without the introduction of rotating parts into the system. Presented at the meeting of the Optical Society, June 4. H.H.S.

Mosaic inlay from Ur. C. L. Woolley. *Illust. London News*, **172,** 1171–76 (1928). —Colored illustrations of mosaic found in excavating Ur of the Chaldees are shown. On one panel is seen the royal family at feast; on the other the Sumerian army in its various branches. The bitumen in which the mosaic was set has been reduced to powder by the course of time, but the *tesserai* have for the most part not shifted from their position. Illustrated also is the bearded Bull of Heaven in gold and lapis lazuli, and the reconstruction of a royal burial with the sacrifice of 59 persons and 6 oxen. H.H.S.

Chinoiserie: Thomas Minton. A. Hayden. *Illust. London News*, **172,** 1188 (1928). —*Chinoiserie* is the interpretative imitation of Chinese art in ornament. Thomas Minton is regarded as its greatest exponent; his "Willow Pattern," laid the foundation of Staffordshire. Among the hundreds of copper plates embodying his designs, there is no meaning. *Chinoiserie*, also, is the hard porcelain which Böttcher of Meissen produced in 1709, and the imitative Delft of the Dutch potters with the rare marks of double jug, peacock, stag, or three bells. H.H.S.

Glass windows in ancient Rome. M. BLASCHKE. *Science Supp.*, **67,** (June 1) 14 (1928).—Glassmaking, known for many centuries in Egypt, came to Rome relatively late. During the time of Cicero, glass objects of any kind were rarities and glass windows were unknown, but 100 years later most households owned some. The famous mosaics of Ravenna and Constantinople in the later Empire were made largely of bits of glass. H.H.S.

The T. C. B. photo-colorimeter. J. PINTE. *Pulp Paper Mag. Can.*, **26,** 171–73, 201–205 (1928). RENÉ TOUSSAINT. *Paper Ind.*, **9,** 1702–1703 (1928). (*C. A.*)

BOOK

English and Irish Glass. W. A. THORPE. The Medici Society, London and Boston, 1928. Price 17*s* 6*d* net. Reviewed in *Pottery Gaz.*, **53** [613], 1129 (1928).—Intended as a guide for those collecting English glass, this work may provide interest and inspiration for all who deal in and produce glassware. T.'s position at the Victoria and Albert Museum has favored this undertaking. A historical summary is given from the coming of the Venetians and Lorrainer in Elizabethan times through the period of the monopolists, the technical expansion under Charles II, the development due to the introduction of a new stream of influence under the Hanoverians, the stimulus of rival political opinions, the effect of the Glass Excise Act of 1745 (in reducing the bulk of metal and the scope for cutting) and of the Irish Free Trade Act of 1780 (inducing glass manufacturers to settle in Ireland). Valuable hints are given for identification of the ware. Technical details are also mentioned. Waterford glass is not necessarily distinguished by a dark blue tint, a very common defect in old glass. Illustrated in color and monochrome. E.J.V.

Cement, Lime, and Plaster

Literature on nature of setting and hardening processes in Portland cement. II. R. H. BOGUE. *Rock Prod.*, **31** [12], 62–63 (1928).—The theory of crystallization from supersaturated solution is considered. The generalizations of Le Chatelier are summarized. **III.** *Ibid.*, [14], 61–62 (1928).—The great strength and water resistance of the cement are explained as due almost entirely to silicate gel formation and its drying out by the inner suction of the cement grains. For part I see *Ceram. Abs.*, **7** [8], 512 (1928). F.P.H.

Producing high alumina slags for alumina cement. T. L. JOSEPH. *Rock Prod.*, **31** [12], 64–65 (1928).—There seems to be little doubt as to the feasibility of operating a blast furnace on a charge of bauxite, limestone, and iron ore, so as to produce a substantial amount of iron and a slag which falls within the range of composition of alumina cements. The Bureau of Mines in coöperation with the Aluminum Co. of America, produced about 70 T. of high-alumina slag in a test run with a 6-T. experimental blast furnace. Low-sulphur metal formed 40–50% of the product. F.P.H.

Lime burning practice. VI. VICTOR J. AZBE. *Rock Prod.*, **31** [12], 66–68 (1928).—The Hoennetal plant of the Rheinisch Westphalischen Kalkwert is described in detail. **VII.** *Ibid.*, [14], 56–57 (1928).—The following subjects are considered: (1) the Wiesloch plant near Heidelberg, (2) small mixed-feed kilns, and (3) hydraulic lime. F.P.H.

Air analyzer for determining the fineness of cement. ANON. *Rock Prod.*, **31** [12], 70–72 (1928).—The principle of the air analyzer is described. F.P.H.

Technical and economic problems of the world's cement industry. C. R. PLATZMANN. *Rock Prod.*, **31** [14], 54–55 (1928).—A survey of the cement industry of the world and the production of cement in 35 countries (1896–1927) are given. F.P.H.

Iron oxide vs. alumina as a fluxing agent for Portland cement. ALTON J. BLANK. *Rock Prod.*, **31** [14], 68–69 (1928).—Beneficial results obtained through the addition of iron ore to normal raw mixtures employed in Portland cement manufacture are dis-

cussed. The economies in favor of high iron raw mixtures over normal raw mixtures are: (1) fuel economy, (2) increased kiln outputs, (3) somewhat better grindability of clinker, (4) increased cement quality, in that it is possible to manufacture a super-cement with high-iron raw mixtures at a lower production cost than it was heretofore possible to manufacture an ordinary Portland cement from ordinary raw mixtures.

F.P.H.

Theory of lime burning. OTTO FRIZ. *Tonind. Ztg.*, **52** [19], 348(1928); *Rock. Prod.*, **31** [14], 95(1928).—The process of lime burning is discussed in detail.

F.P.H.

Accelerated drying of gypsum. ANON. *Tonind. Ztg.*, **52** [20], 379(1928); *Rock Prod.*, **31** [13], 96(1928).—Drying of plaster in new buildings by means of hot air often endangers the quality. Drying by the action of a fan, the air remaining unheated, gives very favorable results. F.P.H.

Change in the definition of slag cement. ANON. *Tonind. Ztg.*, **52** [34], 681(1928); *Rock Prod.*, **31** [12], 88(1928).—As a result of negotiations of professional societies of the German cement industry, the Minister of Transportation has ratified the following change in the German specifications for uniform manufacture and testing of slag cement. Sec. 1, definition of slag cement: "Slag cement is a hydraulic cement containing 15–69% by weight of Portland cement and consisting of basic blast-furnace slag, granulated by rapid cooling of the molten mass. Slag and Portland cement are pulverized and intimately mixed. Only slags from blast furnaces in steel plants having the following composition shall be used for the manufacture of slag cements:

$$\frac{CaO+MgO+{}^{1}/_{3}Al_2O_3}{SiO_2+{}^{2}/_{3}Al_2O_3} > 1$$

The slag shall not contain more than 5% MgO. The Portland cement added shall conform to the definition given in the standards for Portland cement. Special admixtures, for the purpose of regulating the time of set, shall not exceed 3% of the total weight, which excludes the possibility of admixtures to increase the weight of cement. The slag cement manufactured by companies belonging to the Association of German Cement Manufacturers is under strict control of the association, whose members are pledged to manufacture slag cement in accordance with the definition given above."

F.P.H.

Chemical resistance of cement. GRÜN. *Zement*, **17**, 385(1928); *Rock Prod.*, **31** [13], 96(1928).—In a paper submitted to the International Congress for Testing Materials in Amsterdam, G. spoke of the effect of sea-water on concrete. He has also studied the behavior of "Erzzement" (iron cement) when mixed with blast-furnace slag and exposed to the action of various salt solutions and acids. Hemmoor used greater concentration (16% Na_2SO_4). Cements with admixtures of slag have completely deteriorated after one year, while finely pulverized Portland cement did not show deterioration until during the third year, and "Erzzement" after a period of seven years had not deteriorated at all and possessed a strength of 835 lb./in.^{2} Parallel tests of the effect of this solution were made on "Erzzement" and on a first-class grade of Portland cement. While a 10% ammonium nitrate solution was used, the solution of mixed salt contained, in accordance with the molecular ratio, 7.5 g. ammonium nitrate and 12.5 g. ammonium sulphate per 100 cc. water. The Standard Portland cement had completely deteriorated while the "Erzzement" specimens remained practically inert. F.P.H.

Accelerators and retarders of the setting time of plaster of Paris. PETER P. BUDNIKOFF. *Kolloid Zeit.*, **44**, 242–49(1928).—The retarding and accelerating effect of the addition of substances in solution to plaster of Paris was investigated by a thermal method. H.I.

The chemical composition of cement. D. IONESCU BUJOR. *Anelele Minelor din România*, **11**, 31–36(1928).—Cement hydrolyzes in a 1% NaOH solution about the same as in 5% solutions. Only SiO_2 and Al_2O_3 were found in the dissolved part, and no colloidal Fe in the residue, showing that the hydrolyzed portion contains no Fe oxides. Assuming "alite" to be the readily hydrolyzed part of cement, then "alite" is composed only of SiO_2, Al_2O_3, and CaO. Analyses show a constant molecular relation $SiO_2/(Al_2O_3)=3.75$. The residue not dissolved by a 5% NaOH solution has the composition: $(a \cdot SiO_2+b \cdot Al_2O_3+c \cdot Fe_2O_3)$; 2.44 $(m \cdot CaO+n \cdot MgO)$ and since "alite" forms with this residue pure cement whose composition is: $(a \cdot SiO_2+b \cdot Al_2O_3+c \cdot Fe_2O_3)$ 0.284$(m \cdot CaO+n \cdot MgO)$ it follows that "alite" should have the molecular composition: 3.75 $SiO_2 \cdot Al_2O_3 \cdot 11.11$ CaO. This molecular composition of "alite" agrees well with the formula: $4(SiO_2 \cdot 2\ CaO)+(Al_2O_3 \cdot 3\ CaO)$ given by Keisermann for cement clinker. Increase in the ratio $SiO_2:R_2O_3$ in the undissolved residue shows that the yellow-brown substance has in the acid group a $SiO_2 \cdot R_2O_3$ ratio greater than 4.35. This substance contains all the Fe oxides found in cement. Since this yellow-brown substance resists action of a 5% NaOH solution for 5 hours it follows that it cannot be hydrolyzed by contact with H_2O and therefore does not take part in the setting of cement. From the semifused mass which forms cement there solidifies a eutectic in which the chemical-equivalent has been determined by the ratio RO: $(SiO_2+R_2O_3)=2.34$. "Alite" and the yellow-brown substance are deposited simultaneously.

(*C. A.*)

Oxychloride and other dental cements. WALTER S. CROWELL. *Trans. Am. Inst. Chem. Eng.*, **19**, 19–25(1927).—Dental cements are placed in 3 classes: oxychloride cements, heavy metal phosphate cements, and silicate cements. Zn oxychloride cements have been largely superseded by those of the second group, while Zn phosphate cements, as filling agents, have been superseded by the silicate cements. Most recent developments are the substitution of acid-soluble silicates containing Al for Zn or Cu compounds previously used. All dental cements consist of basic powder and an acid liquid mixed immediately before use. At 37°, 4 phosphates of Zn are formed. The range of stability of each is given. Silicate cements resemble industrial porcelain. The necessity of slow setting, the mechanism of setting, and the limited industrial uses of dental cements are outlined, also a means of testing them. Other things being equal, the cement with the lowest shrinkage and highest strength is the best. (*C. A.*)

High-strength cements and cold water. HANS KÜHL. *Zement*, **16**, 660–61(1927).—Normal cement lost 50% while the special cement lost 68% compression strength at 3 days when the mixing and curing temperature was kept at 0–1°. At 28 days the chilled tests had recovered approximately 92 and 85%, respectively, of their usual strength.

(*C. A.*)

Chemical and mechanical laboratory in German cement plants formerly and now. K. GOSLICH. *Zement*, **16**, 727–28(1927).—The development of the technical laboratories during the 50 years' existence of the German Portland Cement Assn. is traced.

(*C. A.*)

Clinker research. WALTER DYCKERHOFF. *Zement*, **16**, 731–35(1927).—In the light of the best American and German investigations, these facts regarding cement clinker are outstanding; the hydraulic properties of cement are furnished by the Ca silicates. The first-formed dicalcium silicate takes up CaO in solid solution from the melt. These crystals of dicalcium silicate therefore differ from the pure compound, especially in its optical properties. Through the influence of the melt some of the di-Ca silicate is converted to tri-Ca silicate to a variable degree. Less $3CaO \cdot SiO_2$ occurs than may be expected from the ultimate analysis. $3CaO \cdot Al_2O_3$ does not occur in clinker. The remaining melt forms ternary compounds of CaO, Al_2O_3, and Fe_2O_3.

It is suggested that the names "alite," "belite," etc., given to not definitely understood constituents be replaced by "dicalcium silicate," "tricalcium silicate," etc. which are known in character and occurrence. (*C. A.*)

Present condition of Portland cement research and the possibilities of producing superior cements. P. H. BATES. *Zement*, **16**, 753–57 (1927).—The discussion includes the possible changes in character of Portland cement with altered proportions of the major constituents, additions of other materials, and improvements in manufacturing processes. (*C. A.*)

Technical research of the American Portland cement industry. F. R. MCMILLAN. *Zement*, **16**, 757–60 (1927).—A discussion of the laboratory of the Portland Cement Association and its accomplishments. (*C. A.*)

PATENTS

Plastic hydrated lime and process of making it. HIPPOLYT DITTLINGER. U. S. 1,664,598, April 3, 1928. As a new article of manufacture a shattered hydrate of lime or finish plasticity as freshly made into putty.

Plastic compositions containing oxychlorides. W. A. OAKLEY. Brit. 281,757, *Stone Trade Jour.*, May 1, 1928; *Rock Prod.*, **31** [14], 94 (1928).—A hot solution of magnesium, ferric, or like chloride is added to a mixture of magnesia and an earthy filler such as carbonate, siliceous or aluminous clay, calcareous earth, kaolin, sand, calcium sulphate, etc. When the filler consists of calcareous earth or alkaline clay a metallic sulphate such as alum may be mixed either with the liquid or solid ingredients. In this case a dry product which sets upon the admixture of water may be obtained by adding the hot chloride solution to the filler and the sulphate, allowing the mixture to set, grinding it, and then adding the magnesia. When the other fillers are employed a small quantity of an alkaline silicate may be added to the chloride solution. The product is useful as an artificial stone or a plaster. F.P.H.

Enamels

Progress report on cast iron for enameling purposes. W. N. HARRISON, C. M. SAEGER, JR., AND A. I. KRYNITSKY. *Jour. Amer. Ceram. Soc.*, **11** [8], 595–608 (1928).—Blisters on enameled cast-iron ware may be traced either to faulty enamels and process of application or to the castings themselves. This investigation is concerned with the latter type of blisters. Differences in the blistering tendencies of different sets of castings were clearly brought out by an enameling test which included a variety of firing treatments. Using this test it was found that not only do different irons have different blistering tendencies, but successive heats of the same iron may have different blistering tendencies. The main source of blisters from the irons used in this work was overcome by removal of a thin surface layer of the castings, through either mechanical or chemical means.

Drawing out economies at the new Fuller-Warren enameling plant. ANON. *Ceram. Ind.*, **11** [1], 56–58 (1928).—A description is given of the plant of the Fuller-Warren Co. of Milwaukee, Wis. F.P.H.

Study of defects of enamelware. K. B. STRONG AND E. R. BRAUNER. *Ceram. Ind.*, **11** [1], 59–61 (1928).—The results of the experiments are summarized as follows: (1) An underfired ground coat causes fishscaling that appears not only in the ground coat but all cover coats as well. (2) An overfired ground coat will develop another type of fishscale in the ground coat, much smaller than that found in the underfired ground coat, that appears, if at all, only as a small dark speck in the first cover coat. (3) Prolonged grinding of the enamel will tend to produce pimples. (4) Aging of the enamel slip over too long a period will tend to develop pimples. (5) An underfired cover coat will produce pimples, while pinholes will appear in succeeding coats. (6) An uneven heating up of

the ware will produce hairlines. Uneven heating is brought about by uneven spraying of the enamel, uneven thickness of metal, and by cold spots or shadows on the ware. (7) A decidedly overfired ground coat will cause pimples and blisters in succeeding coats. F.P.H.

Normalizing overstrain steel by means of electric currents. W. E. WOODWARD. *Fuels and Fur.*, **6** [6], 757 (1928).—Paper presented at the Annual Meeting of the British Iron and Steel Inst. Tests of electric restoration of steel by direct application of electric currents gave uniform results, perfect elasticity being obtained in 3 to 5 minutes. A.E.R.W.

Experimental researches on glasses. I. Study of thermal expansions. L. GRENET. *Le Verre*, **7** [2], 21–24; [3], 41–44 (1928).—This is the first of a series of articles which will cover expansion, fusibility, tensile strength, refrangibility, and endurance of glasses and their relation to chemical composition. G. refers to the work of Fizeau, Schott, and Damour and points out the importance of thermal expansion data using the application of enamel to steel as an illustration. The apparatus of Fizeau (modified by H. Le Chatelier) for measuring thermal expansion is then described; its construction, operation, calibration, and precision are discussed. Schott's additive law was first tested and found to be inexact. The results of experiments performed with simple silicates and simple borates are given in tabular and graphical form. The expansion of the non-devitrified silicates of the alkalis increased with diminishing silica but not according to a simple law. For borates, all the results showed the existence of a definite minimum, the expansion decreasing with small additions of the bases, reached a minimum value and then increased for further additions. This is a direct contradiction of the additive law of Schott. A.E.R.W.

The electrochemical action of inhibitors in the acid solution of steel and iron. E. L. CHAPPELL, B. E. ROETHELI, AND B. Y. MCCARTHY. *Ind. Eng. Chem.*, **20** [6], 582–87 (1928).—The pickling of iron or steel consists in the removal of the surface scale by immersion in acid. By the use of inhibitors the attack on the bare metal is lessened at the same time permitting a fairly rapid solution of the scale. The authors have studied the action of the inhibitors from an electrochemical standpoint. The effect on the separate reactions at the anode and cathode of a cell with the addition of varying amounts of inhibitor was studied. It is found that the decrease in metal solution is proportional to the increase in cathodic overvoltage caused by the inhibitor. By use of a microscope it was found that hydrogen evolution occurs at grain boundaries and slag inclusions. The mechanism of inhibitive action is possibly due to the formation of a blanketing layer of discharged inhibitor substances adsorbed on the cathode areas. R.J.P.

The strength of steel at elevated temperatures. T. MCLEAN JASPER. *Mech. World*, **83** [2155], 294–95 (1928).—Various methods of testing steel, at elevated temperatures in laboratories, and the means of applying these laboratory tests to practical use, are described. E.P.R.

Engineering nonferrous alloys. A. K. GOLD. *Mech. World*, **83** [2156], 311–13 (1928). —In this article an attempt is made to indicate the importance of structure in nonferrous alloys, and its relation to their mechanical properties. E.P.R.

Soldering, brazing, and welding stainless steels. II. A. E. *Mech. World*, **83** [2160], 377–79 (1928).—A detailed description is given of 3 possible methods of brazing stainless steel: blow pipe, dip, and open fire depending on condition and requirements of the work. E.P.R.

Manufacture of vitreous enamels. W. MAVOR. *Pottery Gaz.*, **53** [613], 1121–22 (1928); reprinted from *Chem. and Ind.*, **46**, 1149 (1927); see also *Ceram. Abs.*, **7** [3], 144 (1928). E.J.V.

The action of single constituents on the properties of enamels. ANON. *Keram. Rund.*, **36,** 207–208 (1928).—An article abstracted from the Enamel Hand-book (Email-Taschenbuch, 1928. Published by *Keramische Rundschau.*) H.I.

Antimony white enamels. HANS MELZER. *Keram. Rund.*, **36,** 266–67, 288–89 (1928).—Antimony oxide (in the form of Sb_2O_5) gives greater covering power and better opacity when introduced in the frit than in the mill addition. If excessive amounts of feldspar are used with Sb_2O_5 enamels are likely to be mat, lusterless, and rough, and covering power is lessened. The amounts of quartz and feldspar used should be somewhat greater than in enamels when Sb is not present. A satisfactory ratio of quartz to feldspar is 1:1.25 and of quartz to fluorspar is 0.4:1. Sb_2O_5 is a satisfactory substitute for tin oxide especially in cooking utensils since with the former the ware shows greater resistance to impact and to temperature changes. Using the quartz-feldspar and quartz-fluorspar ratios given satisfactory enamels with as much as 15% Sb_2O_5 added can be made but do not have better characteristics than enamels to which only 8–9% Sb_2O_5 is added. M. concludes that antimony oxide enamels are not poisonous when the oxide is in the form of Sb_2O_5, when the amount used is not excessive, when the proper ratios of quartz to feldspar and to fluorspar are observed, and when strongly reducing conditions are avoided. H.I.

British import duty on enameled ware. ANON. *Morning Post,* June 7, 1928.—A Board of Trade Committee, on a second examination of the facts (having reported two years ago that a duty was not called for) have recommended a duty of 25% *ad valorem* on all imported wrought enameled hollow ware (whether of iron or of steel) except children's toys. H.H.S.

BOOK

The Technique of Vitreous Enameling Cast Iron by Wet Process (Sheet Iron.) JAMES EDWARD HANSEN. Cleveland, O. The Ferro Enameling Co. 203 pp. (*C. A.*)

Glass

Gravity flow process vs. suction feed process. II. B. M. PEARSON. *Ceram. Ind.*, **11** [1], 46–48 (1928).—The second of a series of articles on glass machines. The development of the processes in the early stages and some production figures for the suction feed process are considered. For part I see *Ceram. Abs.*, **7** [8], 527 (1928). F.P.H.

Machining neck molds for glass bottles. ANON. *Ceram. Ind.*, **11** [1], 49–50 (1928).—The machining of molds is discussed in detail. F.P.H.

Making and decorating hollow glass pearls. ANON. *Ceram. Ind.*, **11** [1], 50–55 (1928).—The production of hollow pearls is a special operation in each district of Germany; this industry's product is the genuine gold pearl. This pearl is secured at the blowing table, where the angular openings are heated in the pointed flame and then sprayed with genuine gold. The first pearls of this kind were placed on the market by Parisians and from Paris this art became known in other pearl manufacturing centers. A major portion of the production of pearls comprises also the blown metallized products. In the past they were filled with lead and tin alloy which produced a mirror. Later the silver pearl was developed. The Bohemian craftsman uses a glass rod for the production of pearls; he fuses one end in the pointed flame, reheats the other end, and blows the first pearl. Then he heats further along the rod and thus produces one pearl after the others, until about 12 have been blown from the rod, which are still attached to each other by the center piece. In Thuringia the blown pearl is knocked off and finished before another pearl is started. The method of decorating has to conform to the difference in these two working methods, even though the decorating material and the desired effect are the same. The advantages of these two working methods are these, that the Bohemian worker produces faster and therefore works at less cost;

and the Thuringian worker produces less but thereby secures a finer product which is more desirable. In Bohemia the pearls remain on the rod and are then decorated at once. In the past this was done with the mouth, but since workers were afflicted with various diseases due to the occasional swallowing of the liquids, special instruments were put to use, one a vacuum apparatus which fills the rod with liquid. F.P.H.

Developments in flat glass manufacture. H. K. HITCHCOCK. *Abrasive Ind.*, **9** [7], 182–86 (1928); *Amer. Glass Rev.*, **47** [34], 15–16 (1928); for abstract see *Ceram. Abs.*, **7** [7], 436 (1928). E.P.R.

Copeland addresses Container meeting. ANON. *Amer. Glass Rev.*, **47** [33], 15 (1928). —A plea for increasing the uses of the glass container was voiced by U. S. Senator R. S. Copeland of New York in his address at the recent annual meeting of the Glass Container Assn. C. warned against proposed inimical legislation, with particular reference to the measure for regulation of food containers now before Congress. E.P.R.

Research activities of Container Association. ANON. *Amer. Glass Rev.*, **47** [33], 17–18 (1928).—A report of the broader uses and knowledge of the glass container obtained during the last year by the research bureau of the Glass Container Assn. was made by S. Henry Ayres. The research bureau has just completed the most successful year it has ever had, increasing the number of uses of the glass container and issuing four publications. More efficiency could be gained in the research if more assistants could be afforded. New uses for glass containers are listed. E.P.R.

Operation of "Amco" unit glass melting tanks. W. A. MORTON. *Amer. Glass Rev.*, **47** [38], 15–16 (1928).—To obtain the ultimate form of glass melting tank of the continuous type, the Amsler-Morton Co. of Pittsburg, Pa. has constructed a large number of small recuperative continuous tanks of varying types, utilizing the several industrial fuels. These furnaces are now in successful operation producing good glass economically, and with sufficient variation of result to afford a basis for the determination of procedure to further improve economy, production, and mechanical stability. E.P.R.

National Window Glass Workers to quit. ANON. *Amer. Glass Rev.*, **47** [38], 17–18 (1928).—Dissolution on June 30 of the National Window Glass Workers, once the strongest labor organization in the glass industry, was decided at a meeting of the officers at Columbus, Ohio, June 2–4. This action marked the passing of the hand window glass trade in the U. S. E.P.R.

Formulate flat glass trade practice proposals. J. M. HAMMER. *Amer. Glass Rev.*, **47** [38], 26–27 (1928).—Manufacturers and distributors met in Chicago, June 13 to 14 with the Federal Trade Commission and drew up a code of ethics which the sponsors claim will bring a new basis for the distribution of flat glass. The proposals are aimed especially at unfair trade practice which a few manufacturers and distributors have followed to the detriment of the industry. The proposals cover breach of contract, misbranding, fraud and misrepresentation, unbranded products, substitution quality, secret rebates, inducing sales of other products, price discrimination, free trucking, arbitration, selling without specifications, pooled or combination cars, antidumping. These proposals are discussed in detail. E.P.R.

Melting glass by electricity found practical in Norway. ANON. *Amer. Glass Rev.*, **47** [39], 34–35 (1928).—Cheap hydro-electric power in Norway now is being used in melting glass. The factory is at Moss, Norway, and the electric furnace was built by Vjorn Raeders. In the electric furnace the rate of heating is accelerated to a figure impossible in systems using flame, with the result that dead weight capacity of the flame can be reduced to 1–1.5 times the daily output instead of 8–10 times. There are two ways of applying electricity to glass melting: (1) by use of the electric arc, and (2) by means of resistance. The disadvantages of the electric arc are: (1) intense local heat and high temperature cause loss of alkali, (2) local heating has a serious effect on sur-

rounding brickwork, (3) there is considerable expense and trouble to renew carbons, and (4) the glass is discolored by the carbon. These difficulties may be obviated by using the indirect resistance heating but the disadvantages here are: (1) loss of efficiency due to transmitting heat through clay pots, (2) the pots themselves are a source of trouble, (3) difficulty of obtaining durable resistance material, (4) because of intensely high temperature and local heating the source of heat must be placed some distance from the walls. Molten glass is a conductor of electricity and the glass itself can be used as the electrical resistance element. The advantages are: (1) the heating occurs in every part of the mass of material, (2) the amount of heat transmitted is no longer dependent upon the area of surface exposed to heat radiation, (3) the rate of melting may be accelerated and the dead weight capacity reduced. The first commercial furnace was built in 1925 and produced 330,000 saleable bottles in 3 months. It melted 9 to 10 T. of glass per day. Preventing contamination of the glass by the electrodes may be done in two different ways: (1) the half-molten batch is lighter than molten glass and floats; (2) the electrodes are so placed that they are wholly submerged and the alkali does not come in contact with them; (3) the contact surfaces are kept cool either directly or by using large section electrodes and larger contact area by fluting the electrodes. The electrodes are built into the walls of the furnace and are placed at the sides; 3-phase current is employed. One man can easily tend 3 furnaces. One kw. hr. melts one kg. of glass. Fuel saving relative to coal-fired furnaces is 70%, initial cost is lower, and space occupied by the furnace is less. E.P.R.

Belgian glass sand held dutiable as crude silica. ANON. *Amer. Glass. Rev.*, **47** [40], 17–18 (1928).—The Bureau of Customs, in a ruling made public June 16, has directed the classification of so-called Belgian sand and other sand of that character as dutiable at $4 per T. under paragraph 207 of the Tariff Act of 1922, thereby distinguishing between sand used for glass and flux and that employed in structural operations. This latter sand always has entered free of duty and the placing of the finer grades of sand in the general classification of crude silica represents a reversal of the position which the Bureau had heretofore taken with respect to this commodity. Domestic interests had protested against free entry of Belgian sand, claiming it to be dutiable as crude silica and the Bureau sought the advice of the Geological Survey and the Bureau of Standards. The replies were quoted in the Bureau's ruling. E.P.R.

Glass manufacture. I. America pressed ware. D. KING IRWIN. *Crockery and Glass Jour.*, **106** [10], 32–33 (1928).—A popular article describing the development and manufacture of glass in America. **II. American blown ware.** *Ibid.*, [11], 35–36 (1928).—Methods of making blown ware are described. E.P.R.

Aspects of bottle machine operations. B. M. PEARSON. *Glass Ind.*, 9 [7], 143–48 (1928).—Semi-automatic machines can be operated as fully automatic by the incorporation of a feeding device and a blank transfer mechanism. The automatic machines are such as the Owens machine, English Redfern, and the smaller Continental and English 1, 2, 3, or 4-mold suction machines, such as the Wilzin, the Severin, the McNish, etc. Semi-automatic narrow neck machines are being rapidly replaced by the fully automatic machines, principally of the flow type. Flow machines must be considered from three distinct aspects: the press machine, the press and blow machine, and the narrow-neck bottle machine. Defects caused by variation in temperature of the glass, uneven or feeble air pressure, or chilling of the mold are discussed. There is a limit to the amount of lime which can be used in press and in press-and-blow machines. Too high a lime content will result in crizzles and split rings. The best working figure will generally be about 7.5–8% lime in the glass. Common defects are listed. With all bottle machines, the glass composition must be kept as constant as possible. The Owens machine may work with a wide range of compositions. In the following table are given the typical

working compositions used on the various types of machines. It will be apparent that a fairly considerable diversity occurs in the composition used on any particular machine. Within limits, however, this is not so important as keeping the working composition, once it has been standardized, as constant as possible.

Typical Working Compositions Used on Various Types of Bottle Making Machines

	(1) O.M.	(2) O.M.	(3) O.M.	(4) O.M.	(5) Flow	(6) Flow	(7) Flow	(8) Flow	(9) Flow	(10) Flow
SiO_2	75.00	75.54	73.32	67.65	73.34	73.09	74.13	73.88	74.01	72.0
Al_2O_3	0.53	0.35	0.56	2.92	0.70	1.23	0.37	0.62	1.08	2.1
Fe_2O_3	0.048	0.35	0.56	2.30	0.054	0.36	0.06	0.06	0.17	0.15
CaO	5.10	10.70	7.80	11.32	8.49	8.61	7.90	7.65	7.21	8.5
MgO	3.32	0.05	0.77	0.12	0.13	0.06	0.11	0.16	0.06	0.2
Na_2O	16.00	14.30	16.75	13.55	17.29	16.34	17.43	17.63	17.47	17.00
MnO			0.55	2.14		0.31				

(1) Owens flint, (2) Owens flint, (3) Owens amber, (4) Owens green, (5) O'Neill flint, (6) O'Neill amber, (7) Daubenspeck press and blow flint, (8) Miller press flint, (9) Miller press and blow pale green, (10) Graham flow, pale green. E.J.V.

Designing glass forming molds. Roy E. Swain. *Glass Ind.*, 9 [7], 148–51 (1928).—With compass and dividers the draftsman can determine whether the mold will release the article. There are no instruments or tables to guide in balancing the mold for temperature distribution. A mold may be perfectly balanced for working conditions in one factory yet give a great deal of trouble in another, or a mold that is worked out for one kind of glass may not be suitable for another glass. Paste molds are simple in construction and being water-cooled do not often cause trouble because of temperature distribution. Surfacing with a denser metal and substitutes for cast iron have been introduced. These new materials may modify the design of molds to some extent yet the principles governing the design of cast-iron molds will no doubt apply to these. The designer places the metal in the mold so that the heavier part of the glass blank comes in contact with the heavier part of the mold. The temperature gradient of the blank is considered in balancing a mold. The molds radiate heat to the surrounding atmosphere but all parts do not have equal ventilation. The bottom plates of iron blow molds are often made too light and fail before the bodies of the molds. To give greater radiating surface they are provided with fins. Machine molds are more delicate than hand molds. They are made much lighter than hand molds to enable them to keep hot. The most baffling and difficult molds to work out are the press molds, for the shape of the article often makes it impossible to distribute the metal properly and retain the mechanical strength necessary to withstand the pressure used in forming the ware. A great many ways have been devised for retaining the heat in certain parts of the mold. A few well-known examples are given that show the principles involved. E.J.V.

Technology, uses, and analysis of selenium. J. B. Krak. *Glass Ind.*, 9 [7], 152–53 (1928).—Selenium is being used in glass manufacturing on an increasing scale for four purposes, (1) as a decolorizer, (2) to produce pink colored glassware, (3) for ruby glass, and (4) to make lead amber glass. Selenium was first discovered in 1817 by the Swedish chemist, Berzelius. Its chemical and physical properties are listed, as are methods of preparation. The black sodium selenite (Na_2SeO_3), containing 45.7% selenium or barium selenite ($BaSeO_3$), containing 29.9% selenium is used for decolorizing. The red is rarely used. Manganese does not function well in a reducing atmosphere. Selenium under these conditions produces the best results. One-half ounce of selenium will be ample to use with 1000 lbs. of sand. Since selenium alone may give a slight yellowish tinge, a small amount of cobalt is used in conjunction, giving a slight blue color, which is complementary to the yellow. From one-sixth to one-eighth of the amount of selenium used is the proper quantity of cobalt to be added. The maximum amount of iron that can be eliminated from the view, is about 0.10%. A pink color is

obtained in soda lime, or potash soda lime glasses under oxidizing conditions, by the use of niter. An orange color is obtained with a mixture of uranium and selenium. Selenium ruby can be made in pots and in tanks, using sand, soda ash, zinc oxide, borax, bone ash, cadmium sulphide, and selenium. As little as 0.25% selenium in glass produces a deep ruby color. The selenium ruby color is of a different nature from colors produced by cobalt, copper, etc. These elements color glass in direct proportion to the quantities used. The selenium ruby color does not appear until a certain concentration of the selenium and cadmium is present. Then the color appears with considerable intensity. Variations in intensity may be obtained by skilful reheating, in the glory hole or in the leer. Lead glass may be given an amber color by the use of selenium under oxidizing conditions. Borax helps to bring out the color, and improves the brilliancy of the glass. Reducing agents precipitate selenium as red, elementary selenium from its solution in acids. Sulphur dioxide gas is the most frequently used agency. Hydrazine salts, such as hydrazine sulphate, chloride, or hydrate may be used. Hydroxylamine is preferred by some chemists. Methods for the quantitative determination of selenium in selenium compounds and in ruby glass are outlined. E.J.V.

Coal loader and conveyer handles glass. ANON. *Glass Ind.*, **9** [7], 161 (1928).—Removing 300 T. of molten glass from a furnace is a problem solved by the Thatcher Mfg. Co., with a Barber-Greene coal loader and belt conveyer. The method had previously been to allow the furnace to cool off and then break out the glass with crowbars, sledges, and air drills, after it solidifies. Thatcher drains this glass out while molten, allowing it to run into a rapidly moving stream of water. The glass is quenched and in granular form, in shape to use without crushing. By using their Barber-Greene coal loader and 42-foot conveyer in place of men and wheelbarrows a good part of the labor was eliminated and the time was reduced from 2–3 days to 27 hours. E.J.V.

V. M. Goldschmidt's geochemical work and investigation of silicates and glasses. P. ROSBAUD. *Glastech. Ber.*, **5** [2], 64–66 (1927).—The fundamental idea by which V. M. Goldschmidt governs the advancement of his "model structures" for crystallized silicates and for glasses is to produce models of those compounds whose atoms and ions, with regard to size and properties, are comparable to silicates, whose atoms, however, have lower valence. The relations between crystal structure and chemical constitution in model structures of silicates are brought out, (similarly, titanates and zirconates), by which the difficulties (higher melting point, reaction inertia, and solubility) are greatly reduced. An exactly studied model of one of the silicates is the compound Li_2BeF_4, the model which Goldschmidt has prepared for the silicates of the Willemite-Phenakite group. The properties of the two compounds are compared:

Zn_2SiO_4	Li_2BeF_4
Lattice measurements	
$a = 8.04$ Å, $c = 9.34$ Å $c:a = 1.161$	$a = 7.60$ Å, $c = 8.85$ Å $c:a = 1.165$
Crystallographic properties	
Rhombohedral symmetry	Rhombohedral symmetry
Prismatic habit	Prismatic habit
Cleavage parallel 1010 and 0001 observed	Cleavage parallel 1010 good, parallel 0001 clear
Optical properties	
Double refraction positive, fairly weak, $\gamma - \alpha$ about 0.02	Double refraction positive, very weak, $\gamma - \alpha$ about 0.006
Refractive index about 1.70	Refractive index about 1.3
Solubility	
Insoluble in water	Quite easily soluble, can easily be recrystallized from dilute hydrofluoric acid

Hardness is 5.5 and 3.5 respectively and melting points 1509.6 and about 470°. E.J.V.

Glass sands of the German glass industry. HERMANN HEINRICHS. *Glastech. Ber.*, 5 [3], 49–57 (1927).—A discussion of the chemical and physical properties which are the requisites for glass sands used in the German glass industry. E.J.V.

Chemical resistivity of glasses. G. KEPPELER. *Glastech. Ber.*, 5 [3], 97–112 (1927).—The chemical resistivity of glasses is of great importance in all branches of the glass industry. In order to determine this the concept of "extractability" was introduced. This idea leads to the question of the constitution of glass. The present ideas of the inner composition of glasses are discussed. In carrying out the determination of the extractability (or leaching out) of a glass, it was pulverized and screened between 900- and 2500-mesh per sq. cm. This carefully sized powder was washed free of glass dust with concentrated alcohol, dried, and subjected to the leaching. The same volume, namely 7.74 cc., was always used, and the weight in grams, 7.74×specific gravity was weighed out for the determination. The pulverized glass was heated with 100 cc. of carbonic acid-free water for five hours on a boiling water bath with a return condenser. The liquid was drained off the powder and 75 cc. thereof evaporated to dryness. The total quantity of the leached out material in the 100 cc. in milligrams gives the measure for the "extractability" of the glass concerned. This is naturally an entirely relative methods, but it fulfills its purpose as a comparative measured. The preparation of the products is discussed. Tests of glasses in the system Na_2O-CaO-SiO_2 gave the following results:

Composition			Extractability (mg. per 100 cc. water used)
Na_2O (%)	CaO (%)	SiO_2 (%)	
24.0	0.15	75.85	6300
17.8	0.12	81.1	2300
16.0	2.3	76.4	182
20.3	3.0	76.4	610
21.5	9.3	67.9	108
15.2	5.3	78.8	95
14.1	7.3	77.2	56
18.8	17.9	62.1	50
9.5	17.5	71.5	25

The effects of alumina lead glasses and their resistance to spotting, and the effect of cooling are also taken up. E.J.V.

"White arsenic": coatings on glass in melting and working. LUDWIG SPRINGER. *Glastech. Ber.*, 5 [3], 112–28 (1927).—A discussion of coatings on glass which appear during the melting and working of the glass. Observations made in a glass factory in the Bavarian Forest on "white arsenic," as the coating is known, are listed. Investigations on this coating conducted in one factory are discussed. The coating was artificially produced and investigated. Results of these tests showed that coal gases as well as sulphur gases could produce white coating on glass. With a high content of sulphur dioxide and a sufficiently high temperature, the "white arsenic" can no longer be removed and is fired into the glass. Similar coatings are coatings on melting the edges, fire white glass, and devitrified glass. Spotted and streaked flat glass and methods of determining and removing sulphur dioxide from producer gas are discussed. E.J.V.

Determination of FeO in insulator glasses. HERMANN HEINRICHS. *Glastech. Ber.*, 5 [4], 154–60 (1927).—For the qualitative testing of a glass for FeO, 0.3–0.5 g. of pulverized glass is treated with about 10 cc. of dilute hydrochloric acid, the mixture is heated, filtered, and to the cooled filtrate are added two or three drops of a saturated alcoholic solution of dimethylglyoxime, and the whole is then made ammoniacal. If FeO is present, a deep red color is obtained in this test. For the quantitative determination of both Fe_2O_3 and FeO, more detailed directions are given. Here the Fe_2O_3 is determined, reduced to FeO, and redetermined along with the FeO by $KMnO_4$

titration; from the determination of Fe_2O_3 it is possible to calculate the actual FeO in the sample. E.J.V.

Glassmaking and glass batches of 2500 years ago. E. BERGER. *Glastech. Ber.*, **5** [4], 160–66 (1927); composite of data from "Glassmaking Methods and Batches of 2500 years ago," by R. Campbell Thompson (*Glass Ind.*, **7** [11], 264–67 (1926)) and "Glass in the Early Ages," by W. M. Flinders-Petrie (*Jour. Soc. Glass Tech.*, **10** [39], 229–34 (1926)); see also *Ceram. Abs.*, **6** [1], 13 and [3], 97 (1927). E.J.V.

Effects of carefully annealing optical glass. L. W. TILTON, A. N. FINN, AND A. Q. TOOL. *Pottery Gaz.*, **53** [613], 1110–11 (1928); reprinted from *Jour. Amer. Ceram. Soc.*, **11** [5], 292–95 (1928); see also *Ceram. Abs.*, **7** [6], 349 (1928). E.J.V.

Melting yellow glass. E. FEISNER. *Pottery Gaz.*, **53** [613], 1111 (1928); reprinted from *La Céramique.*—Yellow glass may be obtained by use of different products, such as graphite, charcoal, cadmium sulphide, or silver. When charcoal or sulphur is used it is well to melt broken or pounded glass and to add the composition when it is well melted. E.J.V.

Recipes for glassmaking. ANON. *Pottery Gaz.*, **53** [613], 1116–17 (1928).—A series of fifty recipes for sheet glasses of various colors, bottle glasses of different colors and for varied uses, and glasses for incandescent lamp bulbs. A few of these are:

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Sand	100	100	100	100	100	60	100	100	100	100
Soda	35	35	30	35	40	35	16	8	25	33
Limestone	25	25		18	40		35			
Pyrolusite	5			22						
Iron oxide	1									
Sodium sulphate		3					22			
Powdered charcoal		5								
Red lead			5						20	18
Cryolite			5							
Feldspar			20		30					8
Fluorspar			15							
Bone ash			3							
Arsenic			1							
Cobalt oxide				0.6						
Saltpeter					3				3	
Feldspar sand						120				
Calcite						50		15	12	12
Sodium nitrate						3				
Ironstone							5			
Graphite							12			
Pulverized coke							2			
Zinc oxide								2		2
Borax								6		
Cadmium sulphide								2		
Flowers of sulphur								1		
Potash								32	10	

(1) Sheet glass, reddish violet, (2) sheet glass, carbon yellow, (3) sheet glass, milk white, (4) sheet glass, black, (5) cut glass (especially for perfumery), (6) white glass for strong acids, etc., (7) black glass for bottles, vases, etc., (8) fine yellow glass, (9) glass for incandescent lamp bulbs, (10) glass for incandescent lamp bulbs. E.J.V.

Coloring degree marks on thermometers. ANON. *Pottery Gaz.*, **53** [613], 1118 (1928).—A new material much superior in durability to those now in use, consists of a mixture of waterglass and finely divided manganese dioxide, which is applied as a paste. A thermometer treated with this material retains the color even when heated to 500°C, and can be used in hot oil, water, or steam without injuriously affecting the visibility of the lines. Clinical thermometers may be treated with any of the common antiseptic

solutions without removing this coloring material. The ability of the material to resist attack by acids and alkalis has not been thoroughly tested, but the indications are that it is not entirely resistant to these. Other pigments than manganese dioxide may be used with the waterglass to produce other colors. E.J.V.

New window glass in Sweden. ANON. *Pottery Gaz.*, **53** [613], 1130(1928).—The Sandoe window glass works in North Sweden is about to start the production of the so-called "Hellasan" window glass, also called "Vita" or "Ultravita" glass, which allows the passage of certain ultra-violet rays. The Sandoe concern has acquired the sole right to exploit this invention in Sweden, and will sell its products on the other Scandinavian markets also. The prices will be competitive with those for foreign makes. E.J.V.

Rotary sand driers. ANON. *Glass*, **5** [2], 53(1928).—The drier consists essentially of two concentric cylinders, the inner one of which is fastened rigidly to the outer at a point midway between the extreme ends, and for the remainder of its length is supported by specially designed expansion stays which allow for the free movement of this inner tube with respect to the outer, due to differences in temperature, thus obviating any tendency to buckling of plates or shearing of rivets. The thermal efficiency is of a high order. As the shell rotates the sand is lifted by means of "flights" attached to the outer cylinder, and showered on top of the hot inner tube with which it is kept in contact for about half a revolution. It is then dropped on to the bottom of the outer cylinder and again lifted and showered on top of the inner cylinder. Coke or gas is usually preferred for heating purposes. Bituminous coal, however, has been used in the furnace of this drier without appreciable contamination of the sand. A double-shell drier having a cylinder of about 5 ft. diameter and 30 ft. long will give an output of about 8 T. of dried sand per hour, drying from 10% initial moisture content down to less than 1% final, with an equivalent fuel consumption of about 34 lbs. of coal per ton of dried sand. A.J.M.

Water cooling glass tanks and furnaces. E. F. CARTY. *Glass*, **5** [2], 54(1928).—C. explains and illustrates a tank equipped with water-cooled appliances at the side flux blocks, throat, bridge wall, doghouse, skewbacks, port tongue tile, and shields at the working end. A.J.M.

Great names in the history of English glass. F. BUCKLEY. *Glass*, **5** [3], 103(1928).—B. discusses the work of Joseph and Domynick Cassilari in the 16th Century. Both were Venetians who immigrated to England and played an important part in the development of the English glass industry. *Ibid.*, [5], 199(1928).—The work of Robert Mansell in the 17th Century is discussed. A.J.M.

Manufacture of optical disk. L. MINSKY. *Glass*, **5** [3], 107(1928); for abstract see *Ceram. Abs.*, **7** [4], 222(1928). A.J.M.

Glass furnace construction. A. ALISON. *Glass*, **5** [5], 192(1928).—A. gives detailed calculations for the construction of chimneys. An alignment chart facilitates the determination of the core radius. A graphical method for the determination of the section modulus is given. Self-supporting and guyed chimneys are discussed. A.J.M.

Manufacture and properties of glass and application in illuminating engineering. S. ENGLISH. *Glass*, **5** [5], 212(1928); for abstract see *Ceram. Abs.*, **7** [7], 439(1928). A.J.M.

Constitution of glasses. HERBERT SCHÖNBORN. *Sprechsaal*, **61** [6], 99–101; [7], 117–20(1928).—The thermal coefficient of expansion and the electrical conductivity were determined and data are given of glasses of various compositions which were quenched from different high temperatures. The correlation between the determined physical constants and the quenching temperatures permits the drawing of conclusions

on the molecular constitution of the glasses. In addition the contractions were measured which quenched rods of glass undergo at higher temperatures and the dependence of time and the temperature at which the tests were made are expressed by formulas. Phenomena of inertia noted in viscosity measurements are given. R.A.H.

Stained glass of the Renaissance period. ANON. *Amer. Glass Rev.*, **47** [36], 27 (1928); for abstract see *Ceram. Abs.*, **7** [7], 439 (1928).

History of glassmaking in England. ANON. *Pottery, Glass, and Brass Salesman*, **37** [20], 12 (1928).—References are made to glass in English literature as early as the 9th Century but doubtless this was imported from the Continent. Soon after 1200 glass was being manufactured in England and in 1557 a factory was built at Stourbridge and Newcastle-upon-Tyne. Flint glass was first made in Birmingham near the end of the 18th Century when a glass cutter named Isaac Hawker erected a small glasshouse in a court behind his shop.

Brown coloration of glasses by sulphides. E. ECKERT AND F. H. ZSCHACKE. *Keram. Rund.*, **36**, 203–206 (1928).—Experiments were carried out with small batches of 100 to 250 g. in fireclay crucibles heated in gas-fired and electric furnaces. Larger scale experiments were also made with 120 kg. batches. The basic glasses had the following compositions: *A*, 70%SiO_2, 10%CaO, 20%Na_2O; and *B*, 73%SiO_2, 10%CaO, and 17%Na_2O. The following materials were added in varying amounts in separate series of experiments, (1) coal alone, (2) coal with a clarifying substance (salt cake), (3) coal with a sulphate, (4) sodium sulphide, (5) iron sulphide, (6) iron and H_2S, (7) other gases. It is not advantageous to introduce sulphur in any form in which it oxidizes easily to SO_2 or SO_3 during the melting process. Not only is the sulphur burned out during the melting but the depth of color is not easily controlled since it is largely dependent on the oxidizing or reducing conditions in the furnace. Large amounts of gas are also developed in the glass causing difficulties in refining. It is simpler and safer to introduce the sulphur in the form of sulphate and to transform it to sulphide with strongly reducing conditions. Coal is not a perfect reducing agent and when used in excess produces foaming and consequent refining difficulties. Finely divided metals such as aluminum and magnesium are better reducing agents. H_2S introduced into the refined melt is most satisfactory as the carrier of sulphide and as a reducing agent but cannot be used in melts of commerical size. Iron sulphide introduced as a batch material is most satisfactory as a coloring agent for larger melts. Only enough coal is added to give the necessary reducing conditions. The slight foaming resulting aids rather than hinders the refining. If the tank has been used for sulphide glass and is again desired for colorless glass the glass in the tank may be decolorized by introducing oxygen except where the depth of the tank is great or the bottom relatively cold. H.I.

Glass melting tank furnaces. WILLI M. COHN. *Keram. Rund.*, **36**, 268–69 (1928).—A publication on tank furnaces by the Advisory Committee on Heat Technology of the German Glass Industry (Wärmetechnische Beratungsstelle der Deutschen Glasindustrie, Glasschmelz-Wannenofen, 1927) is reviewed. The publication makes critical comparisons of pot furnaces, day tanks, and continuous tanks with respect to economies in operation, quality of product, and adaptibility to quantity production. Furnaces with regenerative and recuperative firing are compared. Tables of statistics are given. H.I.

Losses in sheet glass production. STANG. *Keram. Rund.*, **36**, 287–88 (1928).—Attention is devoted to the preparation of the raw materials and especially the advantages of using cullet in the melting of wire glass. Sand should be well dried before using. Excessive mixing of batch materials is wasteful since some gravity separation of the batch constituents takes place during storage in the batch bins. Good economies

may be effected in the wire-glass industry by carefully separating the wire from the waste glass, usually by grinding the glass thoroughly, then dissolving the wire and making a final separation with a magnet. Cullet thus recovered shows only a 2% loss in weight in melting whereas a 21% loss in weight is incurred when raw batch materials are used. Cost of recovery of cullet is given as 40% of the cost of raw materials per ton of glass produced. H.I.

Chemical and thermal resistance of glasses employed in laboratories. ARNALDO MAURI. *Le Verre*, **7** [9], 143–46 (1927).—The object of the investigation described by M. was to determine the resistance of some of the best laboratory glasses to chemicals of different concentrations, using concentration, time, temperature, and pressure usually occurring in analytical work. The work of Weber, Post and Neumann, Förster and Mylius, Walker, Cauwood, English and Turner, and Nicolardot is reviewed. In the first series of experiments, boiling water, cold water, and boiling solutions were used at atmospheric pressure; in the second series, the specimens were treated with water in an autoclave at 120, 140, and 160°C. M. decides that it is not logical to try and express the resistance of a glass by means of one value because glasses resistant to one solution may not be resistant to another. The most resistant glasses contain the least lime. Alumina increases the resistance of a number of glasses. *Ibid.*, [10], 151–54 (1927).—The chemical analyses and data obtained by subjecting the following glasses to the usual analytic reagents in an autoclave and over an open flame are reported in the form of tables: Jena (green mark), Jena 20, Murano 22, Murano 23, Pyrex, Labo, Boromica. Conclusions are then drawn as to their resistance to water, acids, alkalis, ammonia, salts, sulphides, etc. A table giving a summary of the results shows that it is illogical to try to classify glasses on the basis of their resistance to any one chemical or the sum of their resistances to a number of chemicals. The surface of contact is more important than the volume of the liquid used. For this reason, and others, autoclave results are more consistent and comparable. Correction coefficients which can be used by the analytical chemist when using the glasses listed for chemical analyses are derived and presented in a table. The resistance of the different glasses to thermal shock and to impact were determined. A.E.R.W.

Ultra-violet transmission of materials. L. C. MARTIN. *Nature*, **121** [3051], 643 (1928).—The ability to transmit the short wave lengths of ultra-violet light is a property possessed by a few materials. Quartz will transmit wave lengths down to 0.18 microns and fluorite will transmit down to 0.125 microns, but these substances also polarize light. Silica glass is but slightly less transparent than quartz and like other glasses does not polarize transmitted light. Silica glass, however, is expensive and it has been impossible as yet to secure a uniform product without local variation in the index of refraction. Common soda glass is practically opaque to wave lengths shorter than 0.33 microns. In Jena glass the increased ultra-violet transmission is probably due to the use of barium. Generally speaking the transparency decreases with increasing proportions of lead in flint glasses. The use of boric oxide tends to increase transparency. Soda decreases the tranparency more than potash. Uviol Jena glass transmits down to 0.28 microns. Fritsch has published particulars of a glass made from fluorite and boric oxide which he claims to be transparent down to 0.185 microns. Vita glass transmits down to 0.272 microns and the new glass put out by the Corning Glass works is claimed to have a greater transparency than that. C.R.A.

The disappearance of gases into glass under the action of the electric discharge. J. TAYLOR. *Nature*, **121** [3053], 708 (1928).—Current was passed through the thin walls of a glass tube containing the gas. It was found that (1) for hydrogen, oxygen, and nitrogen the quantity of gas disappearing was proportional to the electricity passed through the walls; (2) for hydrogen, every electron charge passed involves the disap-

pearance of one hydrogen molecule; (3) for oxygen and nitrogen, every two electron charges passed involves the disappearance of one atom of oxygen or nitrogen respectively; (4) for helium, a current flowed but no disappearance of gas took place. When the current is reversed the action is not reversible and no gas is recovered. It is possible to recover only a small percentage of the gas by heating the glass. The gas does not pass through the glass but remains in it. It is believed that an electrolytic decomposition of the glass takes place, resulting in the case of hydrogen in the formation of water which penetrates deep into the glass structure. C.R.A.

Glass and its enigmas. P. GILARD. *Bull. soc. chim. Belg.*, **37**, 13–34 (1928).—A lecture. (*C. A.*)

The glass electrode. F. J. WATSON. *Chem. Eng. Min. Rev.*, **20**, 59–62 (1927).—The history and evolution of the glass electrode are given with its advantages over the H and quinhydrone electrodes. The accuracy of the glass electrode depends on the thinness of the glass and absence of Al_2O_3. The bulb must be made rapidly to prevent crystallization of the glass. Diagrams are given of 2 successful types and a simple circuit is shown for use of the quadrant electrometer. Prices are given for various electrometers and for a complete outfit ready for use. (*C. A.*)

Glass electrode. W. T. HUGHES. *Chem. Eng. Min. Rev.*, **20**, 105 (1927).—Criticism of Watson. Small quantities of Al_2O_3 (up to 2%) are not fatal to the proper functioning of glass in Haber's cell, although the absence of Al_2O_3 gives markedly better results. In solutions of p_H 9 and higher, there is increasing divergence between the glass and H electrodes; the effect is due to the fact that the impermeability of glass to ions other than H and OH rapidly breaks down in solutions more alkaline than p_H 12–13, with the result that the glass phase rapidly loses H ions, by exchange, the rapidity of this process being greater when the solution contains Li or Na ions, which probably penetrate the glass phase more rapidly than K or Ba ions. If a glass bulb which has been soaking in *N* NaOH is transferred to *N* KOH, the e.m.f. rises immediately to a higher value and keeps on rising for some time. (*C. A.*)

Magnesia glass. HUGO KÜHL. *Glashütte*, **57**, 123 (1927).—A glass which showed an extraordinary resistance to temperature change could be obtained by using a German dolomite of the composition: $CaCO_3$ 55.39%, $MgCO_3$ 41.90, SiO_2 1.65, Al_2O_3 0.90, Fe_2O_3 trace. Flasks made from such a glass containing 4–5% MgO withstood very drastic temperature changes without breaking. (*J.S.G.T.*)

The analysis of a simple soda-lime-magnesia-silica glass, and some pitfalls to be avoided. VIOLET DIMBLEBY. *Glass*, **4**, 374 (1927). (*C. A.*)

Gases in glass. H. SALMANG. *Oesterr. Chem. Ztg.*, **30**, 162–63 (1927).—Equilibria in the gas pressures of glass samples heated up to 1400° under high vacuum were reached for each stage in the heating process. The gases found were not simply in solution in the glass but were evolved from chemical reactions. Glass heated to 1000–1400° under an atmosphere of N_2 and CO_2 did not give off these gases when heating was continued under high vacuum, indicating the insolubility of gas in molten glass. (*C. A.*)

Electrochemical behavior of glass. M. J. MULLIGAN AND J. B. FERGUSON. *Trans. Roy. Soc. Can.*, **21**, [3], Sect. 3, 263–64 (1927).—The brownish spots formed in electrolyzing certain glasses were found to be largely Si. When the glass contained Ag the brownish spots were not apparent, but beautiful dendritic crystals of Ag were formed. The deposits occur at places in the glass at which the high apparent resistance of the anode glass layer has been markedly reduced by current reversal. At 100° the observed falling off of current flow is due almost entirely to the effect of counter e.m.f.'s set up in the glass. The value of this counter e.m.f. is a function of the applied voltage but becomes nearly constant at the higher voltages. The true ohmic resistance of the anode layer could therefore be measured. (*C. A.*)

Glasses of antiquity. BERNHARD NEUMANN. *Z. angew. Chem.*, **40**, 963–67 (1927).—Glasses representing several periods and peoples between 1500 B.C. and 500 A.D. are described. The softening points range from 880° in the earliest period to 742° for the 1st to 5th Centuries B.C. The composition of these glasses approaches that of the 750° eutectic of the ternary system Na_2O–CaO–SiO_2. The low softening points observed are attributed to the presence of several minor oxide constituents. The ancients found empirically the easiest melting mixtures. (*C. A.*)

PATENTS

Sheet-heating means. LEONARD D. SOUBIER. U. S. 1,673,892, June 19, 1928. In sheet-glass apparatus, means for drawing a sheet from a mass of molten glass, means, for deflecting the sheet from one plane to another, means for heating a current of air, means for causing the heated air to be directed downwardly upon the sheet as it is being deflected and then drawn upwardly away therefrom, and means for controlling the intensity of the heating action of air on the sheet.

Sheet-drawing apparatus. NESTOR MAMBOURG. U. S. 1,673,916, June 19, 1928. A sheet-glass drawing apparatus for drawing a sheet from a bath of molten glass including a lip-tile on each side of the sheet, of a pair of coolers arranged between one of the lip-tiles and the sheet, and in spaced relation to each other, one of the coolers being mounted adjacent the lip-tile and having its lower extremity substantially in the longitudinal plane of the lowermost portion of the lip-tile, the other of the coolers being arranged relatively closer to the surface of the molten glass and nearer to the sheet than the first-mentioned cooler to form a shield for the sheet as it is drawn, and to cool the surface of the molten glass before it is drawn.

Cleaning and polishing plate glass. ANTONINO L. M. PIRRONE. U. S. 1,674,263, June 19, 1928. In a device of the class described, having a belt to advance glass plates, the combination of scrapers engageable with the glass plates, means for adjusting the pressure of the scrapers against the plates, a cam element on the belt, and means for urging the scrapers to co-act with the cam element to cause the scrapers to ascend and descend vertically.

Apparatus for drawing glass. ARTHUR E. SPINASSE. U. S. 1,674,529, June 19, 1928. In a glass-tank furnace having a drawing area at one side of the mass of molten glass, a shielding member disposed above and relative to the glass so that the surface of the glass is substantially unbroken, the shielding member being shaped in cross-section so as to equalize the temperature effect of the body of the molten glass on the drawing area.

Apparatus for and method of drawing glass. ARTHUR E. SPINASSE. U. S. 1,674,530, June 19, 1928. In a glass-drawing tank containing a bath of molten glass, a segregating device, means for maintaining the segregating device entirely submerged within the bath below the base of the article being drawn, whereby to provide a segregated pool of glass at the drawing zone with the surface of the pool extending in substantially uninterrupted continuity with and at the level of the surface of the remainder of the bath outside the pool, and means for drawing a glass article from such segregated pool of glass.

Forming figured glassware. EDWARD DANNER. U. S. 1,674,856, June 26, 1928. (1) The method of forming figured glassware, which consists in passing a stream of glass, while in a soft condition, in contact with a figured impression member, and directing a fluid blast co-extensive with the width of the stream against the stream in opposition to the member to force the glass against the member to take the impression thereof. (2) The method of forming figured glassware, which consists in flowing glass in separated films down through a tempering heat, merging the films into a single sheet and permitting the sheet, while still soft, to move into impression taking contact

with a figured roll, one film being less viscous than the other and forming the side of the sheet opposed to the roll, and applying a pressure on the sheet in opposition to the roll to press it closely to the impression surface of the roll.

Glass-mold mechanism. CHARLES E. SCHMUNK. U. S. 1,674,997, June 26, 1928. The combination with a divided mold having a plurality of horizontally pivoted sections, of a pressing plunger, a spring plate associated therewith, a mold ring suspended from the spring plate and having a limited vertical movement with respect thereto, a plurality of toggle elements on the mold ring movable about a horizontal axis into and out of engagement with the mold sections, and abutments on the toggles for contact with the spring plate, whereby the downward movement of the spring plate with respect to the ring will apply pressure to the toggles to move them into clamping engagement with the mold sections, and means for rocking the toggles out of mold engaging position when the spring plate moves upwardly with respect thereto.

Continuous manufacture of plate glass or sheets of glass. CHARLES HEUZE. U. S. 1,675,217, June 26, 1928. (1) A process of manufacturing sheet or plate glass consisting in storing a mass of molten glass in a trough or receiver and causing the molten glass to flow up under pressure between rolling cylinders. (2) Apparatus for manufacturing sheet or plate glass by the method known as "continuous pouring process," comprising in combination: a melting furnace, a trough or receiver communicating therewith below the level of the molten glass and means to control the communication, and inclined wall of reduced height on the trough, a pair of rolling cylinders, one cylinder in front and closely adjacent the inclined wall with its upper side slightly above the upper edge thereof and the other cylinder tiltable about the axis of the former and entering the trough, means to control the advance of the second cylinder into the trough, independent means to control the width of the slit, and means to rotate the cylinders.

Feeding molten glass. JOHN R. KELLER. U. S. 1,675,273, June 26, 1928. The method of feeding molten glass, that comprises placing the glass in a receptacle having a downwardly opening discharge outlet, and also having a stationary impelling member in contact with the glass in the receptacle and oscillating the receptacle around the axis of the discharge outlet, thereby causing the glass to issue periodically from the outlet.

Feeding molten glass. KARL E. PEILER. U. S. 1,675,819, July 3, 1928. In apparatus for segregating mold charges from a body of molten glass, the combination with a glass container provided with a well terminating in a discharge outlet, of a plunger projecting into the well and provided with an internal flow passage communicating with the glass above its discharge end at all positions of the plunger, means for varying the resistance to the flow of glass in the passage, and means for reciprocating the plunger within the well.

Producing crackled glassware. DAVID L. MIDDENDORF. U. S. 1,675,951, July 3, 1928. The method of producing crackled ware which comprises throwing a fluid against the blank of a quantity and quality to produce crackling in the finished article and without changing the temperature of the blank to a degree that will prevent proper shaping thereof.

Producing crackled glassware. DAVID L. MIDDENDORF. U. S. 1,675,952, July 3, 1928. The method of producing crackled ware which comprises causing a fluid to play upon the mold exterior so as to maintain the interior of the mold at such temperature at which crackling of the ware being formed therein will be effected.

Forming glassware. VIRGIL O. CORNWELL. U. S. 1,675,971, July 3, 1928. In the art of molding in block mold, the combination of a block mold having an integral body, a valve structure in the base of the mold and a depression formed in the valve and spaced from the joint between the valve and mold body for imparting a smooth projection to the base of the article.

Glass-cutting table. ALBERT E. EVANS. U. S. 1,676,011, July 3, 1928. In combination with a glass-cutting table, a plurality of roller units distributed over the area of the table and each comprising a lever, carrying two rollers with their axes of rotation at right angles to each other, and pivoted so that in one position of movement of the unit one roller lies uppermost, and in another position of movement the other roller lies uppermost, and means for shifting the units.

Drawing sheet glass. GEORGE H. HARVEY. U. S. 1,676,027, July 3, 1928. The process of producing sheet glass which comprises forming a film on a body of molten glass by applying a moisture spray to the top surface of the glass and then withdrawing the film in sheet formation.

Plate-glass-rolling apparatus. LEE SHOWERS. U. S. 1,676,056, July 3, 1928. The combination with a pair of substantially horizontal glass sheet forming rolls and a runway in advance thereof and extending laterally, of means for guiding the advancing end of the glass sheet formed between the rolls onto the runway comprising a plate in advance of the rolls, a support therefor to which the plate is hinged, and means for moving the plate up into the pass between the rolls with its lower side in contact with the lower roll, and for withdrawing the plate from the pass with the front end of the glass sheet which is formed supported on the plate.

Process of making glass in a shaft furnace. KURT KÜNZEL. U. S. 1,676,267, July 10, 1928. A process of making glass in a shaft furnace, which consists in maintaining a charge of crude glass material in the furnace and carrying a flame upwardly through the shaft and the charge therein.

Heat resistant borosilicate glass. LUDWIG HOCHSTEIN. U. S. 1,676,331, July 10, 1928. A glass composed of silica, boron oxide, alumina, and zirconia, whose coefficient of expansion is approximately 0.0000017.

Process and apparatus for making sheet glass. WALTER COX AND ARNO SHUMAN. U. S. 1,676,772, July 10, 1928. Apparatus for making wire glass comprising the combination of wire mesh embedding rolls of which one is ribbed and the other is smooth, a wire provided in the glass tank furnace wall and discharging between the embedding rolls, and means for continuously passing wire netting or mesh between the embedding rolls along with the stream of glass flowing from the tank, substantially as described.

Making corrugated wire glass. WALTER COX AND ARNO SHUMAN. U. S. 1,676,773, July 10, 1928. The method of making corrugated wire glass which comprises continuously rolling a lengthwise corrugated sheet of glass, initiating the corrugation of a flat wire mesh by securing its end in the first-formed corrugations of the sheet, permitting the flat portion of the mesh to assume corrugated form above the corrugated sheet as the rolling progresses, embedding the corrugated wire mesh in corrugated form into the corrugated sheet, and pressing the roughened surface of the sheet through which the wire passed.

Glassworking machinery. ROY D. MAILEY AND WILFORD J. WINNINGHOFF. U. S. 1,676,795, July 10, 1928. In machinery for working hollow glassware, a set of gas jets projecting toward and movable along a given line, a pair of work holders for supporting a piece of hollow glassware along the line, one of the work holders being movable toward and from the other, a mold movable into operative relation to a piece of work held by the work holders and mounted to move with the jets for movement therewith along the line and a positioning means comprising a latch member having a plurality of latching parts arranged along the line and a coöperating latch member carried by the mold and movable along first the latch member into and out of operative relation to the latching parts.

Glassworking machinery. GEORGE A. MILLAR. U. S. 1,676,796, July 10, 1928. (1) In a glassworking machine, in combination, a member mounted to be rotatable about

and slidable along a given axis, a second member having a face against a face of the rotatable member, means for holding the second member against rotation with the rotatable member and for holding the faces in predetermined relation, one of the members having an arcuate channel between the registering faces and each of the members having an opening therethrough registering with the channel, a gas jet mounted to the rotatable member and connecting with the opening therethrough and a work holder in operable relation to the gas jet. (2) In a glassworking machine, in combination, a guideway, a hollow cylinder rotatable in the guideway and movable longitudinally therein, a collar about the cylinder and movable longitudinally therewith, means for holding the collar against rotation and for holding it in predetermined longitudinal relation to the cylinder, the adjacent faces of the collar and the cylinder having sliding contact with each other, one of the members having an annular channel extending between the adjacent faces and each of the members having an opening therethrough extending from the outside and registering with the channel, a tube connecting with the opening in the collar and permitting movement of the collar longitudinally with the cylinder, a gas jet carried by the cylinder and connected to the opening therethrough and projecting inwardly toward the center of rotation of the cylinder and a work holder in operable relation to the gas jet, means for the application of power to rotate the cylinder about its axis and to slide it along its axis, and a support for the work holder extending longitudinally through the hollow cylinder.

Apparatus for the manufacture of bottles and other glass hollow ware. GUGLIELMO DE RENZIS. U. S. 1,676,981, July 10, 1928. (1) An apparatus for the manufacture of bottles and other hollow ware, comprising a fixed pin, an interchangeable glass supporting disk mounted on the pin, a ring supporting the mold rotatably mounted on the pin, a conical ring coaxial with the latter, means for axially moving the ring, levers actuated by the conical surface of the ring to close the mold, and springs for opening the latter. (2) An apparatus for the manufacture of bottles and other hollow ware, comprising a fixed pin, a stationary support mounted on the latter, a sleeve rotatably mounted on the pin, bell-crank levers pivotally connected with the sleeve, mold sections carried on the upper end of the levers, a concentric conical ring surrounding the sleeve, means for moving the ring into and out of contact with the lower ends of the levers, a gear on the sleeve, a rack bar engaging the gear, and mechanism for reciprocating the rack to impart a circular oscillatory movement to the sleeve.

Manufacturing fire-polished sheet glass. CHARLES J. JORDAN. U. S. 1,677,095, July 10, 1928. An apparatus for forming fire-polished wire reinforced sheet glass consisting in a pot provided with a pair of spaced slots, and being in communication with a furnace, the pot provided with a third slot equidistant of the 1st-named slots, means for regulating the active width of the 1st-named slots, guides extending diagonally from the 1st-named slots and converging at a point remote from the pot and in alignment with the 3rd slot, and air domes in the pot over the 1st-named slots to apply air pressure to molten glass in the pot and means for controlling the communication between the pot and the furnace.

Apparatus for annealing glassware. BRIT. HARTFORD-FAIRMONT SYND., LTD. Brit. 279,835, Oct. 20, 1927. (*C. A.*)

Glass manufacture. GENERAL ELECTRIC CO., LTD. Brit. 287,545, May 16, 1928. A method of making light-diffusing glass, particularly suitable for electric lamp bulbs, consists in pulverizing clear glass and then fusing the pulverized material to form a viscous mass which is blown to the desired shape. The air bubbles enclosed in the viscous mass cause the finished glass to be turbid and of an opalescent appearance. The raw glass is pulverized in a ball mill, and it may be compressed into bodies of predetermined size before being fused. The fused mass may be blown in the usual way, or a quantity may be gathered on the end of a glass tube which is used as a blowpipe and

may also supply part of the finished bulb, such as the neck. Coloring or opacifying agent may be added to the pulverized mass before it is fused.

Glass manufacture. BRITISH THOMSON-HOUSTON CO., LTD. Brit. 287,566, May 16, 1928. Method of making electric lamp bulbs by means of a machine which gathers charges of molten glass by suction, the blanks thus formed being dropped from the gathering mold on to the upturned end of a blowing spindle. A blank, as usually formed has an intermediate flange and a constricted end portion. A bulb blown from such a blank has to undergo a separate operation for the removal of the moil before the filament mount can be sealed into the bulb. The blank is formed without the constructed end portion and the intermediate flange, and is clamped on the blowing spindle by its edge which is gripped by a flange on the usual pivoted clamping members. A bulb blown from a blank of this form has a bead instead of a heavy moil, and the opening in the neck is large enough to permit the insertion of the filament mount.

Manufacture of composite glass. H. J. MALLABAR AND NON-INFLAMMABLE FILM CO., LTD. Brit. 288,782, Feb. 24, 1927. A relatively thin layer of cellulose acetate, capable of being cast from solution in continuous rolls, is fastened by gelatin between sheets of glass. Bonding is secured by drying the gelatin layer with which the surfaces are coated, treating with a softening liquid, and uniting under pressure. Before applying the gelatin layer to the surface of the cellulose acetate, the latter is suitably treated, as by partial hydrolysis or with a solvent liquid, while the glass surface is prepared by coating with a gelatin solution containing a hardening agent. The gelatin layer for bonding is made by dissolving this substance in a water-acetic acid-methyl alcohol-acetone mixture. The glass may be rendered colorless by imparting a bluish violet tint to the cellulose acetate, gelatin, or glass. (*B.C.A.*)

Annealing glass. UNITED GLASS BOTTLE MFRS., LTD., E. A. C. PRYOR, AND F. A. HURLBUT. Brit. 289,501, June 20, 1928. In the annealing of glassware in a tunnel leer the ware is cooled rapidly and uniformly from temperatures considerably above the lower critical annealing temperature by first subjecting the ware to the upper critical annealing temperature, and then passing it through a part of the leer where it is surrounded or enclosed at top, bottom, and sides by a medium which permits of rapid dissipation of heat. This portion of the leer is preferably made of metal, and may be cooled externally by air or other temperature controlling medium flowing transversely around it. When cold air is passed into the leer for rapid cooling below the lower critical annealing temperature, a hinged plate, adjusted according to the height of the ware, prevents travel of the air to the hotter parts of the leer. Existing leers may be modified by fitting sheet metal cooling sections adjacent the firing or entry end.

Glass-annealing leers; conveyers. THERMAL ENGINEERING CORP. Brit. 289,790, June 27, 1928. Glass articles such as bottles, jars, etc., are fed while still hot, from a molding-machine in single file to a leer in which they are annealed by their own heat and which is provided with a roller-way conveyer and with means for arranging the articles in rows transversely of the leer.

Glass manufacture. C. H. RANKIN. Brit. 290,083, June 27, 1928. A feeder has a tubular weight-regulating member or sleeve, or a rotatable and axially movable sleeve. An axial reciprocatory movement is imparted to the member in which the sleeve is mounted, and the means for effecting the axial movement is also adapted to hold the member stationary in different positions of adjustment. The feeder can thus be used either with the sleeve reciprocating between adjustable limits, or with the sleeve held stationary at any desired distance above the outlet orifice. The rotation of the sleeve stirs the glass in the forehearth, and to assist the stirring action, the sleeve may be made with regular or irregular corrugations, ribs, or beads on its interior or exterior surface.

Electrical insulators of glass. "OSA" PARTICIPATIONS INDUSTRIELLES SOC. ANON. French 618,186 and 618,288, July 1, 1926. In addition to silica, the glasses contain potassium oxide, sodium oxide, and one or more bi- or ter-valent oxides, and, if necessary, boric oxide. Minimum electrical conductivity is obtained when the potash: soda ratio is within the limits 7:1 and 3:1. The soda may be replaced by iron oxide. (*B.C.A.*)

Lead glasses. "OSA" PARTICIPATIONS INDUSTRIELLES SOC. ANON. French 618,659, July 7, 1926. Calcium oxide (2.5–3%) is added to ordinary glass batches containing silica, soda, potash, and lead, to increase their electrical insulating properties. (*B.C.A.*)

Heavy Clay Products

Driving clay-working machinery. DAVIS BROWN. *Bull. Amer. Ceram. Soc.*, **7** [8], 228–34 (1928).—Illustrating and describing the application of various power transmitting and speed reducing devices with suggestions for further simplifying the methods of applying motors to machines to be driven.

Fuel mixing with clay. R. C. GANGWERE. *Bull. Amer. Ceram. Soc.*, **7** [8], 234–36 (1928).—The question of fuel cost reduction is very pertinent. Mixing cinders with clay produced a granular structure which stimulated drying and reduced firing expense. Other methods tried are mentioned.

Variety of clays of Washington and their adaptability to ceramic industry. EDWARD BURKHALTER. *Bull. Amer. Ceram. Soc.*, **7** [8], 236–39 (1928).—A brief description of clays in the northwest which have a proven industrial value.

Mortar: its importance in the life of brickwork. J. A. VAN DER KLOES. *Brick Clay Rec.*, **72** [13], 914–16 (1928).—The effect of certain ingredients in mortar as observed in European brickwork is discussed. The statements are based on the premise that clayware is permeable to water. No information as to the degree of vitrification of the ware is given, or of its other properties, which would have important bearing on the observations such as porosity, absorption, texture, position in structure, etc. Two causes for spalling are (1) the internal pressure caused by the expansion of material within the pores and (2) osmosis. These are discussed in detail. Several other items of interest are mentioned. E.J.V.

Mining and manufacture of clay; a technical survey. G. A. BOLE AND H. E. NOLD. *Brick Clay Rec.*, **73** [1], 34–37 (1928); reprinted from Ohio State Univ., Eng. Expt. Sta., *Circ.*, No. 14, May (1928); see also *Ceram. Abs.*, **7** [7], 500–502 (1928). E.J.V.

Hollow building tile in the clay products industry. S. F. HECKERT. *Clay-Worker*, **89** [6], 464–65 (1928).—The history of hollow building tile is as interesting as any of the many phases of the clay industry. Though old in point of service to humanity, it is still in its infancy when considered from the standpoint of building construction generally. As permanent construction develops and the idea becomes more generally accepted, it will be found that hollow tile will come more and more into world-wide usage. E.J.V.

Alliance Clay Products Co. produces new products. ANON. *Clay-Worker*, **89** [6], 466 (1928).—The "Alliance Randams," are brick in multiple of standard size brick, plus one-half inch mortar joint. These are made to slight variations due to variation in shrinkage in firing of materials, but variations are not materially greater than in standard brick. E.J.V.

Two new products much in demand. ANON. *Clay-Worker*, **89** [6], 466 (1928).—The Standard Brick and Tile Co. of Macon Ga., is producing two new clay products which have created quite a demand. One is the Jumbo brick, $3^1/_2 \times 7^3/_4 \times 12$ inches, which displaces $4^2/_3$ brick and is given preference to concrete block and stone tile. The

other is the Balloon brick, somewhat larger in size than ordinary brick, being $2^1/_2 \times 3^3/_4 \times 8$ inches, but the same in weight due to eight slots in it. E.J.V.

Brickmaking in New England. F. A. WESTBROOK. *Clay-Worker*, **89** [7], 554–55 (1928).—One of the large and up-to-date plants of the New England Brick Co. is located at Epping, N.H. The equipment of this plant is described in some detail. Owing to the location of the plant the production season lasts only from May 1 to October 1, during which time about six million brick of the sand struck variety, chiefly common brick, are made. E.J.V.

Antifriction bearings in the clayworking plant. C. W. RICHARDS. *Clay-Worker*, **89** [7], 557–60 (1928).—The use of antifriction bearings decreases power bills and also effects a saving in lubrication and maintenance expenses. Though the successful application of antifriction bearings to clay-processing machines is recent, the spread of their use has been rapid, following the developments in the design of the bearings themselves which produced types suitable for any sort of service. Few machines used in the brick plant are not fully equipped with antifriction bearings. How some of the mechanical and physical problems of these machines have been solved by the use of tapered roller bearings is outlined, together with some of the results accomplished. E.J.V.

Evolution in brickmaking and brickmaking machinery. VIII. GEORGE M. FISKE. *Clay-Worker*, **89** [7], 562–64 (1928).—Mechanical brick handling by the Penfield system is discussed. Where the Francis device handled 110 brick, that of the Penfield system handles units of 1000 to 1500. The machine handles a full carload of brick each time, in setting a kiln, and the setting is more even than by hand so that the firing of a kiln is much more successful. For preceding abstracts see *Ceram. Abs.*, **7** [7], 448 (1928). July abstract incorrectly numbered; should read VII. E.J.V.

Factory design and equipment. XV. T. W. GARVE. *Clay-Worker*, **89** [7], 565–66 (1928).—Power requirements for a new clay plant are discussed. The actual requirements together with the calculator's experience and knowledge of the material in question and the equipment should be considered. There is a variation in power required depending on too many different factors to make any definite relationships being established. Power data are presented which are approximated for average conditions for a shale of medium hardness and average output. For preceding abstracts see *Ceram. Abs.*, **7** [7], 448 (1928). E.J.V.

Doulton's new pipe works. ANON. *Brit. Clayworker*, **37** [434], 98–104 (1928).—An illustrated article on a modern ceramic plant. R.A.H.

Dry clay moistening device. ANON. *Brit. Clayworker*, **37** [434], 104 (1928).—A shute fitted with sprays to moisten clays used in the stiff-plastic process for manufacture of brick is described and illustrated. R.A.H.

Thermometers for presses. ANON. *Brit. Clayworker*, **37** [434], 104 (1928).—Some clay can be pressed more rapidly and satisfactorily if heated during the process by either steam or gas. A check on the temperatures at various times may be kept by means of special type of thermometer which is let into the lower part of the die in such a position as to enable it to be easily read. R.A.H.

Physico-chemical phenomena in building materials. J. W. MCBAIN. *Stones Trade Jour.*, May 1, 1928; *Rock Prod.*, **31** [14], 94 (1928).—Experiments at Bristol University on moisture sorption and dye sorption of building materials are reported. A summary of typical results is given. F.P.H.

Brick construction and its economy. RIEMER. *Tonind. Ztg.*, **52** [19], 339–42 (1928).—Various types of brick construction are discussed and compared. F.P.H.

Process of making porous, foamy, and dry blast-furnace slag by means of water, steam, or air. LUDWIG VON REICHE AND JULIUS GIERSBACH. *Tonind. Ztg.*, **52** [33], 658 (1928); *Rock Prod.*, **31** [13], 96 (1928).—A method is described for making dry slag. F.P.H.

Resistance of materials to frost action. ANON. *Tonind. Ztg.*, **52** [33], 658 (1928); *Rock Prod.*, **31** [14], 95 (1928).—Hirschwald (Bautechnische Gesteinsuntersuchungen, Report of the Mineralogical-Geological Institute, Kgl. Techn. Hochschule, Berlin, Vol. 1, p. 20 (1910)) says that water expands by $^1/_{10}$ of its volume in changing to ice. When the pores of a rock are uniformly filled with water to the extent of $^9/_{10}$, freezing results in a complete filling of the pores with no particular pressure, so that the rock remains unchanged by frost action. Only when saturation is carried beyond $^9/_{10}$, the ice finds insufficient room in expanding and produces cracks. On the basis of this, Hirschwald developed a theory that completely water-soaked rocks yield to frost action no matter what their strength, while incompletely water-soaked rocks resist this action even when their strength is low. As pointed out above, a rock, saturated to $^9/_{10}$ was designated by Hirschwald as "incompletely" saturated. For various reasons the present investigator sets the limit value at 0.8. The accuracy of this value was confirmed by hundreds of specimens. He also published a method of determining the "saturation coefficient," which consists in determining absorption of one specimen by immersing it for 1–2 hours (W_2) and that of a completely water-soaked specimen saturated under pressure after complete evacuation (W_c). The ratio W_2/W_c gives that part of the pore volume which is filled through capillary action. Materials, used for structural purposes, have a "saturated coefficient" of 0.8. Although in past years Gary has argued against this method (*Zeits. Ver. Deut. Ing.*, p. 727 (1912)) it is entitled to a place in testing structural materials, for it is evident that the commonly accepted test is too strict for materials which are never completely soaked by precipitation in nature, so that many a suitable material is eliminated as nonresistant to freezing. F.P.H.

The silicification of roads. L. GESCHWIND. *Genie Civil*, **88,** 519–23 (1926).—Silicified roads composed of crushed calcareous rocks bonded by a silicate and rolled give an elastic tough unified surface satisfactory for vehicular traffic and showing even wear. Maintenance is easy and cheap and cost of laying is low. Roads of this type in parts of Switzerland and neighboring France have given very satisfactory service. Liquid silicate of soda with a ratio $SiO_2:Na_2O=3.15$ is used as bonding material. After the silicate has been poured on the stone and rolled the liquid diffuses by capillarity into the mass of the material. Diffusion is accompanied by a type of dialysis, the silicate penetrating to the interior showing a much lower $SiO_2:Na_2O$ ratio than that near the surface. Drying and hardening then take place, both of these processes being irreversible. H.I.

Silicification of highways built of chalky limestones. L. GESCHWIND. *Genie Civil*, **88,** 545–47 (1926).—Studies on the use of sodium silicate as a bonding material for crushed limestone roads (*ibid.*, **88,** 519–23) were continued. Soft chalky limestones with an initial compressive strength of 45–75 kg./cm.^{2} were impregnated repeatedly with sodium silicate, drying periods intervening between each impregnation, until a compressive strength of 467–572 kg./cm.^{2} was obtained. G. concludes that while satisfactory highways could be built by this method using these materials the costs would be excessive. H.I.

PATENTS

Brick-cutting machine. FRANK B. DUNN. U. S. 1,674,197, June 19, 1928. A brick-cutting machine adapted to reciprocate during the cutting operation, a driven shaft, a shaft mounted transversely to the driven shaft, gear mechanism to actuate the transverse shaft, means to regulate the rotation of the gears and transverse shaft with relation to the driven shaft, a crank on the transverse shaft, an arm on the frame of the brick-cutting machine, a hook on the free end of the arm adapted to engage the crank on the upward movement thereof.

Display case for brick. WILLIAM C. KOCH. U. S. 1,676,445, July 10, 1928. In a device of the class described, a tray adapted to receive a plurality of brick samples arranged in rows, a series of parallel spacing strips severally disposed between rows of the samples, the strips being free for lateral movement to permit ready insertion of the samples between them, a flexible bar extending adjacent to the inner face of a side of the tray in parallel relation to the rows of samples and a series of screws threaded in the side of the tray and arranged to extend through the side with their inner ends impinging against the bar whereby all of the samples and strips may be shifted laterally to exert lateral gripping pressure upon the several samples.

Drying sanitary pipes and other clay goods. G. O. LAWTON, S. DOWTHWAITE, AND ALBION CLAY CO., LTD. Brit. 289,225, March 15, 1927. (*B.C.A.*)

Brick machines. E. HOLE. Brit. 289,230, June 13, 1928. Clay is fed by a pugmill into a chamber fitted with a reciprocating plunger beneath which is reciprocated a carriage carrying a mold and a dummy.

Refractories

Effect of reducing gases on the transverse strength of fireclay bricks. A. E. R. WESTMAN. *Jour. Amer. Ceram. Soc.*, **11** [8], 633–38 (1928).—It was reported that fireclay brick, when heated in the presence of carbon monoxide, were disintegrated by the progressive deposition of finely divided carbon at the "iron spots" in the brick. The conditions necessary for the occurrence of this phenomenon were not definitely known although the known reversibility of the catalytic reaction around 650°C and the outcome of small scale experiments indicated that disintegration would not occur above this temperature. To obtain more definite information on this score, the effect of city gas at 550°C and 1100°C on the transverse strength of three brands of fireclay brick was determined. No significant changes in strength occurred at 1100°C. At 550°C two of the brands suffered very significant decreases in strength, but the other brand was unaffected, although it had the highest iron content.

Apparatus for observation of thermal expansion of refractories from 20 to 1800°C. ANON. Bur. Stand., *Tech. News Bull.*, No. 134, pp. 85–86 (1928).—The Bureau has undertaken the study of the thermal expansion or contraction of a number of different refractory materials from 20 to 1800°C. The temperatures are supplied by a high frequency induction furnace having a hollow cylindrical core of graphite 6 x 12 x 1/2 inch in which the heat is generated by induced current. Specimens approximately 6 in. long and 1 in. in cross-section are used for the determinations. Temperature is measured at either end of the specimen by means of thermocouples up to 1400°C and at higher temperatures by use of the optical pyrometer. The expansion of the specimen and table on which it rests is indicated on a micrometer dial graduated to 1/10,000 in. A correction for the furnace and set-up due to expansion is applied. R.A.H.

Flow of heat through furnace hearths. J. D. KELLER. *Fuels and Fur.*, **6** [6], 743–52 (1928).—K. gives equations and diagrams for calculating the flow of heat through hearths of the solid or nonventilated types. The following cases are considered for steady state conduction: (1) circular hearth with an adiabatic outside earth surface through which heat cannot flow, (2) circular hearths with thin side walls, (3) circular hearths with side walls of finite thickness, (4) very long hearths with parallel sides, (5) square or rectangular hearths. Diagrams were prepared in which the relations between the ratio r/R and the ratio R/Le for the cases listed where r is the radial distance of the point whose temperature is to be calculated, R is the radius of the circular boundary (or its equivalent in the case of noncircular hearths), and Le the equivalent length of heat flow path for parallel steady heat flow. The complications resulting from surface resistances, varying proportions, temperature variation with time, and water in the ground,

are discussed and methods for allowing for their effects in design given. The following general conclusions can be drawn from the form of the equations and charts: (1) the total heat flow through hearths of a given shape is proportional, not to the area but only to the diameter or width; (2) the equivalent thickness of the hearth at its center is slightly more than one-half the (inside) least width of the hearth; (3) the rate of flow is least at the center, increases at distances farther from the center, and approaches an infinite value at the edge; (4) almost one-third of the total heat loss escapes through the outermost 5% of the hearth width; (5) increasing the side-wall thickness reduces the loss through the hearth; (6) insulating a hearth by placing a horizontal layer of the usual kinds of insulating material on the top of the foundation is not very effective; (7) the presence of water in the ground at relatively shallow depths may not only increase the heat loss but may even endanger the stability of the furnace. A.E.R.W.

Refractories for brass foundry furnaces. H. M. St. John. *Fuels and Fur.*, **6** [6], 795–98 (1928).—The requirements for refractories to be used in the following furnaces are discussed: (1) crucible pit furnaces using coke or hard coal, (2) crucible furnaces using oil or gas, (3) open-flame furnaces using oil or gas, (4) indirect-arc electric furnaces, (5) induction electric furnaces. The general requirements are as follows: refractoriness, resistance to spalling, metal penetration, liquid or gaseous fuel penetration, resistance to slag, resistance to chemical action of metals and fluxes, behavior in oxidizing or reducing atmospheres, electrical conductivity, heat conductivity, mechanical strength and cohesiveness, and ease and convenience of use. In general it may be said that preheating, patching and special care by the furnace operators lengthens the life of the refractory. More expensive linings for electric furnaces will prove the most economical. A.E.R.W.

Silica brick in the open-hearth furnace. B. M. Larsen. *Blast Fur. Steel Plant*, **16** [6], 803–807 (1928).—Investigation is made of the changes that take place in silica brick under conditions that are met with in service particularly in the open-hearth roof. F.P.H.

Refractories and the open hearth. J. R. Miller. *Blast Fur. Steel Plant*, **16** [6], 807–808 (1928).—Severe conditions of service at vital points make the refractory problem one involving not only material quality but great care on the part of the user. F.P.H.

Some common abuses of fire brick. L. S. Longenecker. *Blast Fur. Steel Plant*, **16** [6], 809–11 (1928).—Special attention is directed to two features in furnace construction that involve unduly severe service, (1) irregular joints and (2) keyed arch roof. F.P.H.

Kaolinic refractories and their properties. Mark J. Terman. *Blast Fur. Steel Plant*, **16** [6], 814–15 (1928).—Kaolinic material is processed by a new method which develops its refractory qualities to the fullest extent producing a recrystallized refractory with a maximum uniformity of quality and size. The melting points of the regulating refractory are: 3200°F in oxidizing atmosphere and 3165°F in reducing atmosphere. A study of the linear expansion curve, shows that there is no permanent volume change in the refractory up to 2900°F and only a slight shrinkage up to 3000°F. The average coefficient of expansion of the refractory is 0.00000242. The curve shows the expansion of the refractory to be small and that the point at which permanent volume change begins is about 2900°F. It should also be noted that this refractory has practically a straight-line expansion which explains its unusual resistance to spalling. While considering permanent volume change, it is important to note that this refractory does not "grow" under continued heat exposure and that no precautions need be taken in the designing and construction of furnaces to allow for this. F.P.H.

Testing refractories for the furnace. W. Boyd Mitchell. *Blast Fur. Steel Plant*, **16** [6], 815 (1928).—The responsibility of the manufacturer of fire brick and of the purchaser in selecting the appropriate brand is defined and suggestions are offered. F.P.H.

Working temperatures of refractories. M. C. Booze. *Blast Fur. Steel Plant*, **16** [6], 817 (1928).—

		(°F)
Blast-furnace tuyeres		3150
Blast furnace	Slag	2650–2750
	Metal	2625–2700
Open-hearth furnace during boil		3100
Medium hard steel at tapping		2800–2900
Gas leaving producers		1000–1200
Gas leaving regenerators		1600
Air leaving regenerators		2000
Waste gas at stack		1000–1500
Steel ready to roll	High sulphur	2300
	Soft steel	2200
	Spring steel	2000
Crucible steel furnace		2650
Rotary cement kiln on clinkering		2850
Shale drain tile firing		1900
Fireclay stoneware firing		2200
Fireclay sewer pipe (hottest)		2200
Shale sewer pipe		2000
Fireclay paving brick		2100–2200
Shale paving brick		2000–2100
Under a boiler	Stoker fired up to	2800
	Powdered coal fired up to	3050

In the heating furnace the temperature obtained was for a 24-in. ingot being heated for forging: back wall temperature, maximum 2500°F smaller stock varying according to the size and shape of the piece being heated; the average within the heating furnace is approximately 2500°F for rolling. Where stock is being heated for welding, the temperature will be 200 or 300° higher than this. In the electric furnace for steel melting, steel is ordinarily supposed to be tapped at a temperature about 50° higher than from an open-hearth furnace. Some actual comparative ratings, however, gave temperatures between 2850 and 2950°F for an electric furnace making ordinary steel. In glass pots, temperature will vary between 2200 and 2700°F, depending upon the kind of glass being melted. A fair average would probably be 2600°F. F.P.H.

Properties of magnesite bricks. Hans Hirsch. *Stahl u. Eisen*, **48** [12], 371–72 (1928).—An abstract of Paper No. 117 des Werkstoffausschusses des Vereins deutscher Eisenhuttenleute. The physical, mechanical, and refractory properties of magnesite bricks from 32 sources are reported. The bricks were divided into three main groups on the basis of the Fe_2O_3 content, namely: (1) those containing more than 7%, (2) those containing 3–7%, and (3) those containing less than 3% Fe_2O_3. Bricks containing 5–7% Fe_2O_3 and very small amounts of SiO_2 have the best sintering properties and the greatest mechanical strength. F.P.H.

New economical process for zirconia. Trapp. *Chem. and Ind.*, **47**, 624 (1928).—Without publishing any details of the process in question, T. states that an entirely new process has been developed which will considerably lower the price of ZrO_2, and which will extend its use as a refractory material. H.H.S.

World supplies of chromium. Anon. *Engineering*, **125**, 440 (1928).—The world production of Cr is now more than double what it was in pre-war years. The bulk of the ore is extracted in British (Rhodesia and India together, 65%) and French (New Cale-

donia, 12%) territory. Other Cr-producing countries are Greece, Turkey, and Cuba. The uses of Cr are for stainless steels, refractory linings, and tanning. H.H.S.

Fused quartz. FELIX SINGER. *Keram. Rund.*, **36**, 289–91 (1928).—A report on a paper presented before the Electrotechnical Union, Berlin, Feb. 13, 1928 giving the physical and chemical properties of fused quartz. H.I.

Furnace walls and their maintenance. WALTER J. MAY. *Mech. World*, **83** [2153], 249–50 (1928).—The lining of any furnace is, as nearly as can be arranged, made of material that will withstand heat without fusing, but the backing need not be so refractory. Ordinary fireclay brick fuses at 2500–3000°F and ordinary fire clay somewhat lower than this, so there is no great margin in these where forced draft is concerned. A good silica brick and grating should be used in contact with the actual fire. An order of resistance of fire brick to fusion is given but the exact fusing point depends on composition. The ordinary solid wall may be a composite or may be of refractory brick throughout, but no fusible jointing can be permitted on the fire side. Perfectly shaped bricks should be selected for facing work. Some furnaces are best if lined with one refractory slab but unequal expansion must be considered. Carr's crucible furnace, made of a lining tube in one piece backed with a fireclay conglomerate, is an example. Where refractory linings are air-cooled, two or three inches of air space between the linings and the solid wall is sufficient to keep them from fusing. Some sort of support between the lining and brickwork is necessary depending on the size and purpose of the furnace. Projection of iron is efficient. In some furnaces, plates are used on the outside walls to prevent bulging. The rods carried through iron tubes to keep them cool and a short stiff spiral spring placed under each nut will prevent spreading. Where arches cause trouble due to expansion it is best to have iron supports and drop the arches into position on soft nonfritting fire clay. E.P.R.

Ramming linings for cupolas. ANON. *Refrac. Jour.*, **3** [28], 677–78 (1928).—A well-rammed lining gives good service for more than 2 years with a minimum of expense on patching and better insulation is obtained because of the compression of the rammed material. Installation is simple and inexpensive but the selection of material requires care. It should be ordered several days prior to its use as it must be laid aside under cover to permit excessive moisture draining off. If this is not done shrinkage may result and the lining crack with the application of heat. Material to fill space between pattern and casing to a depth of 3 or 4 in. is rammed down solid and a further 3 or 4 in. is filled and rammed, until the top is reached. The pattern should not be raised more than 4 inches at a time, as this is the greatest depth of ramming allowable if the finished lining is to be compact and solid. Shrinkage should average less than a quarter of an inch if the material is of right consistency when rammed. The lining must be well-vented immediately following which a slow fire may be lighted. E.P.R.

Shrinkage of fireclay refractories. M. C. BOOZE. *Refrac. Jour.*, **3** [28], 687–88 (1928).—Shrinkage is a considerable factor in the manufacture and use of fireclay refractories. Its reduction to a minimum and its control will result in considerable saving. The great influence of grinding upon shrinkage is not generally understood. It has been shown that the linear drying and firing shrinkages of coarse and fine flint plastic clay mixtures varied from 4% for the coarse to 7% for the fine. If it is not feasible to vary the grind purposely, it should at least be kept uniform by control tests in order to reduce variations in size. Nonplastic or flint clays, unless finely ground, have little drying shrinkage, while semiflint clays have considerably more, and plastic clays a maximum. When flint or nonplastic particles are as large as $^1/_4$ inch in diameter and there is a relatively small amount of fine nonplastic present, crazing or cracking of the bond takes place. It can usually be corrected by the use of 20–30% finely ground grog or calcine. Firing shrinkage is affected by the characteristics of the clays used, the grind, the manner of setting, and by the firing treatment. E.P.R.

Brick for open-hearth furnaces. A. T. GREEN. *Refrac. Jour.*, **3** [28], 690–91 (1928); for abstract see *Ceram. Abs.*, **7** [4], 234 (1928). E.P.R.

Utilization problems of metallurgical limestone and dolomite. OLIVER BOWLES. Am. Inst. Mining Met. Eng., *Tech. Pub.*, No. 62, 14 pp. (1927).—A brief compilation of data on the effects of chemical composition and physical character of the stone on its action in the blast furnace and on the quality of metal produced. The action of flux in the furnace, the effect of impurities, and the slagging effect of MgO and its effects on slag viscosity, the matter of choice between limestone and lime, and the use of dolomite as a furnace lining are briefly discussed. (*C. A.*)

Improvements in blast-furnace construction. J. P. DOVEL. Am. Inst. Mining Met. Eng., *Tech. Pub.*, No. 73, 3 pp. (1927).—D.'s patented improvements include: the insertion of a series of rows of bronze cooling-plates from the outside attached to and supported by the shell and substitution of a heavy cast-steel jacket lined with cast-iron blocks for the old type brick top-section. The latter results in a permanent stock line and good resistance to wear. (*C. A.*)

Melting pot and crucible furnaces in the aluminum industry. E. R. THEWS. *Metal Ind.* (*London*), **31**, 597–99 (1927); **32**, 3–4, 204 (1928).—A discussion of the various melting appliances and of refractory materials for Al melting with attendant advantages and disadvantages. Characteristic properties of Al and of the slags are mentioned. Resistance of melting pots to corrosion, absorption of Fe by Al and the manipulation of the pots and the advantages of using crucible furnaces for small quantities or intermittent melting are pointed out. Producer gas or oil is used and tilting furnaces have very largely replaced the old stationary types. The grades of graphite available and the treatment and storage of the crucibles are discussed. Either graphite blackening or Al-bronze varnish makes a good protective coating for crucible walls. Oil-fired crucibles are subjected to corrosion due to oxidation of graphite. Precautions in pouring the crucible and means of avoiding of internal strains are mentioned. (*C. A.*)

PATENTS

Blast furnace. WILLIAM PATRICK POWER AND ESSINGTON LEWIS. U. S. 1,664,832, April 3, 1928. In a blast furnace, the combination with an upper lining of means for supporting the same connected to the outer shell of the furnace independently of the lower lining.

Firebrick construction for locomotive fire boxes. PHILIP H. CONNIFF. U. S. 1,674,241, June 19, 1928. A locomotive fire box having side sheets and a water circulating and steaming element spaced therefrom in combination with a firebrick arch extending from side sheet to side sheet, the firebrick arch being composed of complementary brick which contact the lower portion of the water circulating and steaming element and enclose the bottom thereof, at least one of the complementary bricks being held in place by a plurality of upwardly extending brick having mutually leaning contact one with the other at one end and one thereof engaging the side sheet while the other engages the complementary brick, the complementary brick having a portion inclined to the vertical plane and forming a seat for the last-mentioned brick in engagement with it.

Refractory article and material. GRANT S. DIAMOND. U. S. 1,674,961, June 26, 1928. The method of making refractory articles which comprises mixing an oxide of magnesium and crystalline graphite with a carbon binder and a quantity of a glaze, forming the mixture into the articles desired, baking the articles, applying to the baked articles a coating of a further quantity of the glaze, and then rebaking them.

Baking the linings of crucibles. FRANZ STÖHR. U. S. 1,675,735, July 3, 1928. The method of baking the refractory linings of crucibles provided with an open top at one end and a tap opening at the other end, which comprises applying a closure to the

open top of the crucible, projecting a combustible fluid jet through the opening, and venting the products of combustion through the tap opening.

Fused silica. QUARTZ ET SILICE. Brit. 287,522, May 16, 1928. A method of making transparent fused silicia, using quartzites consists in melting as large blocks as possible of the quartzite without deformation by packing the blocks into an electric resistance furnace with a filling of pure sand. After fusion, the cooled ingot is cut up by any suitable means and the flawless portions are separated and used for optical purposes. Other portions, which may not be optically homogeneous, are brought into shape or again treated.

Refractory substances for furnace linings. LABORATOIRE DE PERFECTIONNEMENTS THERMIQUES. Brit. 287,556, May 16, 1928. Walls and other parts of furnaces exposed to the injurious action of slag, clinker, etc., are protected by a coating having a graphite base preferably mixed with a soluble silicate, *e.g.*, sodium silicate. The composition may be applied to an existing furnace or to the bricks before building into the furnace. Proportions are specified.

Regenerator bricks. K. KNIEPERT. Brit. 289,282, June 13, 1928. A regenerator brick is formed with walls not at right angles to the base, so as to give an interrupted flue passage.

Refractory substances. J. S. WITHERS. Brit. 289,560, June 20, 1928. Mullite, containing 72% or 3 molecules Al_2O_3 to 28% or 2 molecules SiO_2, is prepared by the treatment in an electric furnace of a mixture of minerals high in aluminum-silicate content, such as cyanite, andalusite, sillimanite, or pyrophyllite, with an amount of approximately pure alumina necessary to bring the ratio of alumina to silica to the value indicated above. The added alumina may be obtained from bauxite, diaspore, or alunite, or may be natural corundum containing fluxes (iron oxide, titania, magnesia lime, or alkalis) less than 2% of the total. Silica may be as high as 6%. Where the product is to be used as a refractory lining to resist glasses or enamels of an essentially alkaline silicate character, the porosity may be reduced by the employment of alumina containing potassium oxide and phosphorus pentoxide, such as the residue left as a by-product in the recovery of potash from alunite. For the manufacture of general refractory ware, such as fire brick for boiler linings, alumina admixed with these oxides is to be avoided. The ingredients are ground to a fineness of at least 40-mesh and roughly briquetted or agglomerated into small nodules with thin molasses-water. A 3-phase furnace is employed, the pot being one-third filled, broken coke piled on the charge, and the arc struck. Additional charge is fed around the arc, the electrodes being lowered quickly in the pool as it forms. The rapid formation of a deep pool is essential, the elimination of iron and ferro-silicon depending on the fluidity.

Preparation of refractory bodies. VER. F. CHEM. AND MET. PROD. French 618,339, June 7, 1926. Magnesia, calcined dolomite, etc., in paste form, are mixed with concentrated colloidal solutions of titanium oxide or titanium salts; products are formed from the mixture, with or without the application of pressure, dried and fired. The products are denser than ordinary magnesia bricks. (*B.C.A.*)

Terra Cotta

Spray room control with a camera. HARRY E. DAVIS. *Jour. Amer. Ceram. Soc.*, **11** [8], 639–43 (1928).—The use of the camera for recording spray room applications is described and its advantages over the old method of keeping actual samples of each spray which soon forms a bulky, dusty accumulation, subject to accident and deterioration. The problem of distinguishing between colors, where several applications are made, remains to be solved.

Experiments on terra cotta slips. E. C. HILL. *Pottery Gaz.*, **53** [613], 1117 (1928); reprinted from *Jour. Amer. Ceram. Soc.*, **11** [4], 260–63 (1928); see also *Ceram. Abs.*, **7** [5], 305 (1928). E.J.V.

Stoneware for the collector. WALTER A. DYER. *Arts and Dec.*, **29** [3], 58 (1928).—An article describing and illustrating early American stoneware. Many shapely pieces prove that old potters had a sense of form and proportion. Decorations range from a date to choice birds of the Spencerian flowing line. Before the Revolution there were only a few stoneware potteries, famous names being Ramney (1750–1890) and Crolius (1762–1820). E.B.H.

Porcelain as structural material. H. HANDREK. *Z. Ver. deut. Ing.*, **71**, 1553–60 (1927).—The physical and chemical properties of porcelain are compared with those of the several metallic and nonmetallic structural materials commonly employed in industry. The effect of temperature upon the density, electric resistance, and mechanical strength of porcelain is discussed. (*C. A.*)

BOOK

Die Chemie des Ziegelmauerwerkes. EDUARD DONATH. Vol. 30 of the "Sammlung chem. und. chem.-techn. Vorträge." Stuttgart: F. Enke. 74 pp. M. 6.50. (*C. A.*)

White Ware

Effect of lepidolite in a high tension electrical porcelain body. ROBERT TWELLS. *Jour. Amer. Ceram. Soc.*, **11** [8], 644–48 (1928).—Lepidolite is a lithium mica which has had considerable commercial application in glass and enamels. Its use in porcelain has not been tried to any great extent. This work covers the replacement by lepidolite of the feldspar in a high tension electrical porcelain. The results show that changing the RO of the standard body by molecularly replacing K_2O by Li_2O raises the vitrification temperature of the body, but that replacing feldspar directly pound for pound by lepidolite greatly lowers the vitrification temperature of the body. Lepidolite gives porcelains having a fine appearance and extreme whiteness. The most important property noted is an improvement of the bodies containing lepidolite in resistance to thermal shocks. Owing to its higher cost it is unlikely that lepidolite will be used in porcelains except in small proportions with feldspar to produce bodies having special properties. As hitherto the most important applications of lepidolite will doubtless be in glasses and enamels where full benefit can be secured from its fluorine content and low fusion temperature.

Small investments in the pottery which pay dividends. MARC SOLON. *Ceram. Age*, **11** [6], 220–21 (1928).—Contamination due to particles of bedding material carried from the biscuit kiln to the glaze can be removed as quickly as it enters by means of a constant circulating, constant sieving device described by S. A line sketch is given. Advantages over the usual method of screening twice a day are as follows: (1) cleaner glazes, (2) constant circulation and therefore better uniformity in the glaze, (3) relieves dipper of screening operation, and (4) eliminates thinning of the glaze for lawning. A.E.R.W.

Tariff situation in the whiteware industry. FREDERICK H. RHEAD. *Ceram., Ind.*, **11** [1], 65 (1928); *Pottery, Glass, and Brass Salesman*, **37** [21], 11–13 (1928).—The present tariff is 70% on decorated porcelain, 60% on undecorated, 55% on decorated earthenware, and 50% on undecorated, but with no practical methods of figuring dutiable value. Because of this, more than $^1/_3$ of the whiteware plants in the U. S. are not operating and more are closing each year; less than $^1/_8$ of the pottery and porcelain sold in this country is made here, and Japanese imports have increased more than 1200%. E.P.R.

Opportunities for floor and wall tile. ANON. *Clay-Worker*, **89** [6], 473–74 (1928).—There are to be found in the trend of things in the structural world today more opportunities for the marketing of floor tile and wall tile to say nothing of roofing tile, than at any time in the period of the industry. These include use of floor and wall tile in baths and showers, in the kitchen, and use of floor tile in basements, sun rooms, and on porches. E.J.V.

The color method in ceramics and in the investigation of minerals. R. RIEKE AND O. WIESE. *Ber. deut. keram. Ges.*, **9** [3], 109–55 (1928).—The action of organic colors on ceramic bodies and minerals is used as a basis for studying the effect of heat (firing temperature) in causing the changes taking place when various bodies are fired. The color method can be used as a control method in studying the vitrification of bodies and as an indicator of the firing temperature to which a body has been subjected. A list of organic colors used in the investigation is given. The effects of heat and dyes on the following minerals and bodies fired to various temperatures were studied: (1) aluminum oxide, (2) silicic acid and its various modifications, (3) calcite, (4) fluorite, (5) magnesite, (6) talc, (7) dolomite, (8) Norwegian feldspar, (9) potash mica, (10) Zettlitz kaolin, (11) Zettlitz kaolin plus calcite, (12) Zettlitz kaolin plus magnesite, (13) Zettlitz kaolin plus quartz, (14) Zettlitz kaolin plus feldspar, (15) Zettlitz kaolin plus mica, (16) Zettlitz kaolin plus fluorite, (17) feldspar plus quartz, (18) feldspar plus alumina, (19) quartz plus iron oxide, (20) quartz plus magnesite, (21) Zettlitz kaolin plus quartz plus feldspar, (22) quartz plus alumina plus calcite, (23) calcite plus magnesite plus feldspar plus Zettlitz kaolin, (24) various porcelain bodies. A bibliography on the subject is given. F.P.H.

Crystal formation in ceramic bodies and glazes. R. RIEKE. *Ber. deut. keram. Ges.*, **9** [3], 156–68 (1928).—A discussion is given of the effect of crystal formation in ceramic bodies and glazes on the physical properties of the bodies and glazes. The conversion of kaolinite to mullite is discussed in detail. Factors influencing the formation of crystalline glazes are considered. F.P.H.

Evaluation of clays and bodies by determination of the distribution of particle size of quartz by elutriation. H. HARKORT. *Ber. deut. keram. Ges.*, **9** [4], 189–202 (1928).—The progress of vitrification of ceramic bodies is determined by the time and temperature of firing and the size of the particles. A number of clays with varying amounts of quartz is included in the investigation. The distribution of particle size of the quartz particles is determined by elutriation using the Schulze-Harkort elutriator. The clays are fired, glazed, and refired. The effect of the amount and size of the quartz particles on the crazing of the glaze is studied. F.P.H.

Strain in glazed ware and its detection. W. STEGER. *Ber. deut. keram. Ges.*, **9** [4], 203–15 (1928).—The various methods of detecting strain in glazed ware are enumerated as follows: (1) estimation of the tension in a glaze by the number, type, and size of fissures formed in the glaze; (2) quenching test of body and glaze by quenching from various temperatures until failure results; (3) shrinkage test according to J. Dorfner (*Sprechsaal*, **47**, 522–26 (1914)) in which a cylinder is partly glazed and the shrinkage of the glazed portion noted; (4) optical measurement of the double refraction of the strained glaze; (5) measurement of coefficient of expansion and modulus of elasticity of body and glaze separately; (6) method proposed by S. in which a strip of body is glazed on one side and the curvature of the resultant glazed body determines the sign and magnitude of the strain. The fit of glaze and body is determined by heating the specimen in a test furnace and determining at what temperature the strain is relieved. The effect of composition of glaze and glost-firing temperature on the glaze fit is studied. F.P.H.

Electrical porcelain plant operated by remote control system. ANON. *Ceram. Ind.*, **11** [1], 34–37 (1928).—A description is given of the new plant of the Square D. Porcelain Co. F.P.H.

Porcelain plumbing manufacturers adopt commerical standards for fixtures. ANON. *Ceram. Ind.*, **11** [1], 37–38 (1928); see also *Bull. Amer. Ceram. Soc.*, **7** [7], 221 (1928). F.P.H.

Modern Russian porcelains. MAX SCHNEIDER. *Keram. Rund.*, **36,** 189–91 (1928).—Examples of modern Russian ceramic ware are described and illustrated. H.I.

Cementing high tension insulators. KARL WAGNER. *Sprechsaal*, **61** [6], 97–99 (1928).—A discussion on the preparation and method of application of cements to high tension insulators. R.A.H.

Authenticity of old china. ALEXANDER SCOTT. *Science Supp.*, **67** (April 13) 14 (1928).—Chemical tests in the laboratory of the British Museum have helped to classify several doubtful pieces in the museum collection without disfiguring the specimens. Old patent acts were consulted to determine the chemical composition of Old Bow and Chelsea china, and tests were then made for various phosphate components. H.H.S.

The toughness of white ware. R. RIEKE AND L. MAUVE. *Ber. deut. keram. Ges.*, **8** [1], 61–62 (1927).—Increasing the firing temperature increases the resistance to impact on the edge or bottom of the ware. (*C. A.*)

Steatite. W. DEMUTH. *Z. ver. deut. Ing.*, **71,** 1566–68 (1927).—Steatite is well adapted to particular ceramic uses such as electric insulators especially for high voltage. Steatite can be worked well and develop great body strength and density when fired. (*C. A.*)

BOOKS

Symposium on Faults in Alkaline Slip Casting. Published by the National Council of the Pottery Industry, Stoke-on-Trent, England.—The principal discussions on the subject were given by T. Simpson, Arthur Hollins, and Walter Emery. The principal faults encountered in alkaline slip casting are: (1) *Flashing:* Various terms assigned to the peculiar markings which occur on goods cast with alkaline slip, are flashing, scubbing, spotting, etc. The affected area is usually very dense and vitreous making satisfactory glazing almost impossible. In some cases it is accompanied with discolorations. The fault developed during the "filling" operation and where the slip first "hits" the mold. The phenomenon is more or less independent of the type of body or the presence of alkalis. (2) *Pinholing*: This defect occurs intermittently irrespective of type of body or presence of alkaline deflocculents. The percentage losses are less with soda slips. The defect is to a large extent influenced by type of slip used, volume of air in slip, condition of mold, actual "filling" methods and relative temperatures of slip and mold. Wet mold is a frequent cause. (3) *Wreathing*: The slip gelatinizes and does not clear the molds, leaving wreaths. The fault when removed reappears after firing. This defect must not be confused with ridges caused through the difficulty of casting the shape. Improperly prepared slip is mainly responsible for wreathing or roping. (4) *Hair lines or parting*: This fault appears as a dividing line midway between the two outer surfaces. Layers of clay "built up" on both halves of the mold. In the absence of pressure the speed of "casting up" is determined by the type of body, condition of slip, and permeability of the mold. As no more slip enters to replace the water removed by absorption, a narrow cavity results extending throughout the center of the piece. By the application of pressure, *e.g.*, a tall funnel filled with slip, it is possible to force slip into the mold to replace the water. (5) *Balling or coring*: This peculiar defect is probably due to discontinuous casting mainly oc-

casioned by the shape of the piece. Any device that will retard the rate of casting in the thinner or accelerate the speed in the heavier portions should be adopted. Auxiliary feeds help to overcome the trouble. In many cases molds have "loose" sections inserted in the constricted portions made from a special mix possessing a very low permeability factor. F.P.H.

Fabrication Industrielle de Porcelaines. MARC LARCHEVEQUE. Matières premières et leurs traitements. Paris: J. B. Baillière et fils. 480 pp. (*C. A.*)

PATENT

Process of making tile. THEODORE C. AND WILLIS O. PROUTY. U. S. 1,677,098, July 10, 1928. The process of making an integral multiple tile body having the appearance of an assemblage of a plurality of tiles, which comprises the operations of molding under pressure a dry bisque mixture by means of dies of the form of the desired multiple tile body and one of the dies having thereon a relief design outlining the forms of a plurality of separate tiles and adapted to form grooves in the face of the multiple tile body, firing the multiple tile body so formed to produce the bisque, applying glaze mixture to the areas of the bisque between and defined by the grooves, again firing the tile body bearing the glaze mixture so applied, and subsequently filling the grooves with cement.

Equipment and Apparatus

Chromium plating discussed. E. G. LOVERNUG. *Abrasive Ind.*, **9** [4], 108–10 (1928).—The growing use of chromium as an electroplating coating has developed a situation which merits the study of all platers and industrial executives. Advertising would convey the idea that the deposition of chromium is as practicable as the deposition of nickel, whereas, it is generally known among electroplaters that there are many cases where chromium plating is not practicable. There are two methods at present to produce chromium productively, when a high finish is desired: (1) a bright flash deposit, a sort of metal lacquer, and (2) the dull deposit (5–30 minutes) and buffed afterward. Buffing costs on chromium are high compared with nickel coloring. E.P.R.

The "Conquest Mill." CONQUEST MILL ENG. CO., LTD. *Mech. World*, **83** [2155], 293 (1928).—Three classes of machinery for grinding disintegrators are given; ball, ball and tube mills, and pulverizers of the ring-roll type. The latter is the most popular for reduction of hard and refractory materials to powder. Grinding takes place here between the faces of a number of rolls and a grinding ring. "Conquest Mill" was evolved to remedy high maintenance charges caused by lack of flexibility and high speeds. It has a flexible carrier producing an action on the roll-heads similar to that of a mortar and pestle, and from which are suspended the roll-heads and shafts; a positive drive is also incorporated. The mill gives an output of one ton per hour on Midland coal to a fineness of 80% through 200-mesh, while granite, slate, silica oxides, etc., also have high efficiencies. A flour content of 50% has been obtained. E.P.R.

Spiral conveyer details. H. A. *Mech. World*, **83** [2158], 339–40 (1928).—A. discusses improvements in lubrication, an outfall improvement, by which the tendency to throw the material can be overcome by tapering off the ends of the spiral so as to produce a mean result, double screw conveyers which provide for dealing with material that is not immediately absorbed by using two conveyers having their troughs firmly rivetted together, and each end-plate embracing the two sections, transfer-port improvement in transferring material from one scroll to the other by means of a few inches lead in the transfer-ports. E.P.R.

Thermostatic control of temperature in industrial heating processes. W. D. CROUCH. *Fuels and Fur.*, **6** [6], 827–28 (1928).—By using expansible members made

of different metals, special leverage, and suitable location for valves it is possible to secure very satisfactory results from thermostat valves at temperatures ranging from 50 to 2000°F. A.E.R.W.

Paper covering saves money in clay storage. ANON. *Brick Clay Rec.*, **73** [1], 38–39 (1928).—Sisalkraft is a material that will cut down storage costs on raw material, unfinished product, and finished product. According to the claims made by the manufacturer, it is moisture proof, air tight, flexible, and tough. Experience of a large terra cotta company with this paper covering used in its clay storage department are related. It is thought to be the solution to many problems in the stiff-mud branch of the clay products industry. E.J.V.

Use of draft gages in the ceramic industry. W. STEGER. *Ber. deut. keram. Ges.*, **9** [3], 169–74 (1928).—The following subjects are discussed: (1) fundamentals of draft measurements, (2) the draft gage and its construction, (3) various types of gages, (4) installation of draft gages. F.P.H.

Drying ceramic products. WIRTH. *Ber. deut. keram. Ges.*, **9** [5], 299–311 (1928).—A discussion is given of the fundamentals of drying ceramic products. The drying equipment manufactured by the Firma Benno Schilde, Machinebau-A.-G. Hersfeld, Germany is described. F.P.H.

Elutriation of clays. ANON. *Keramos*, **7** [7], T5 (1928).—The construction of elutriators for the purification of clays is discussed in detail. F.P.H.

Presses and pressing. ANON. *Brit. Clayworker*, **37** [434], 96–97 (1928).—The choice of press should be based on the nature of the articles to be made and on the consistency of the clay or body. Some hints are given in the proper operation of presses in general and how to avoid troubles. R.A.H.

A new Amsler apparatus for the measurements of the permeability of concrete. PIERRE BREUIL. *Genie Civil*, **88**, 66–67 (1926).—A method of measuring the permeability of concrete reported on by E. Stadelmann before the Swiss Society of Engineers and Architects is described. A cylindrical vessel holding a concrete cube 20 cm. on a side is filled with water above the cubical specimen and is connected by a tube to a reservoir containing air or an inert gas under pressure. A hole beneath the specimen allows the water passing through to empty into a graduated flask. Devices are provided for rendering the lateral walls of the specimen impermeable and for maintaining a constant gas pressure during the test. The permeability of the specimen is measured by the amount of water passing through in a unit of time under constant pressure. Tests made indicate that poured concrete is more permeable than tamped concrete and that tamped concrete is more permeable perpendicular to the direction of tamping than parallel to the direction of tamping. Further experiments are necessary to confirm these indications. H.I.

An illuminator for use in metallographic microscopy. LEWIS E. JEWELL. *Jour. Optical Soc. Amer.*, **14**, 159–65 (1928)—As a substitute for the plain glass mirror inserted in the tube of the microscope above the objective for vertical illumination, a polished steel mirror with a straight edge covering only half of the field and with a semi-elliptical notch in the edge at the center of the field is suggested. This type of mirror affords a combination of relief illumination and illumination by specular reflection. With an iris diaphragm above the mirror the relative amounts of the two types of illumination may be changed. H.I.

Master scales in the service of the ceramic industry. A. KARSTEN. *Keram. Rund.*, **36**, 185–86 (1928). H.I.

Modern conveyer systems as used in the ceramic industries. FR. LIPINSKI. *Keram. Rund.*, **36**, 261–66 (1928).—Types of conveyers especially applicable to the ceramic industry such as chain and cable ways, continuous belts, vibratory conveyers

screws, scrapers, bucket conveyers and various types of electric and dumping cars are described and illustrated. H.I.

Electrical methods of hygrometry. P. W. BURBIDGE AND N. S. ALEXANDER. *Engineering*, **125**, 487 (1928).—Two electrical methods for the measurement of humidity are considered: (1) depending on the change in resistance of organic materials (cotton, wool, hair) on exposure to water vapor, (2) on the change in mobility of ions due to water vapor. Results showed that in (1) the change in resistance is not linear, and that in (2) the effect produced is too small for accurate measurement. H.H.S.

BOOK

The Modern Calorimeter. WALTER P. WHITE. Amer. Chem. Soc. Monograph. No. 42. 194 pages. The Chemical Catalog Co. Inc., New York, 1928. Price, $4.00, Reviewed in *Ind. Eng. Chem.*, **20** [6], 664 (1928). R.J.P.

PATENTS

Crushing and separating apparatus. PAUL L. CROWE. U. S. 1,654,638, Jan. 3, 1928. A grinding and separating apparatus of the character set forth comprising a base, a fan casing carried by the base, a plurality of fan units arranged within the casing, a conduit projecting from each side of the fan casing, and grinding cylinders arranged concentric with each of the conduits.

Crushing apparatus. PAUL L. CROWE. U. S. 1,654,639, Jan. 3, 1928. A crushing apparatus of the character described comprising a pair of crushing plates, each plate having a downwardly and inwardly directed portion defining a crushing jaw and a downwardly and outwardly directed portion defining a cam engaging plate, means for pivotally supporting the plates at points adjacent the apex of the angle defined by the portions, and a cam interposed between the downwardly and outwardly directed portions of the plates and adapted to engage both plates simultaneously to oscillate the same.

Conical crushing mill. HUGO ACKERMANN AND WILHELM LANGENHEIM. U. S. 1,656,895, Jan. 24, 1928. A conical crushing mill including a conical crushing mantle, a shaft and a seating element fixed to the shaft, a mass of hard lead or similar material filling up the intermediate space between the crushing mantle and the seating element, steps on the seating element, one or more of the steps of the seating element being undercut.

Process and apparatus for magnetic separation. FRANCIS M. SIMONDS. U. S. 1,660,362, Feb. 28, 1928. The process of separating magnetic from nonmagnetic particles which consists in causing the mixed particles to move across a magnetic field of force and subjecting the groups formed by the field to disintegrating blows as they move toward the source of the magnetic attraction.

Controlling the movement of masses of solids of various sizes. LOUIS E. W. PIODA. U. S. 1,663,173, March 20, 1928. The process of controlling the gravital movement of a mass of relatively finely divided solids of various sizes from a container through a discharge outlet in the bottom thereof in which movement pockets of air are entrapped in the mass in the container, which comprises venting the entrapped air from the mass before the air pocket reaches the discharge outlet.

Centrifugal grinding mill. WILLIAM A. GIBSON AND JAMES G. BURKE. U. S. 1,663,881, March 27, 1928. In a contrifugal grinding mill comprising a grinding chamber having therein a horizontal annular grinding ring, coöperating centrifugally actuated grinding members and a superposed air separating chamber communicating with grinding chamber, means for admitting air to the grinding mill above and substantially adjacent to the grinding ring and adjustable means operable selectively to direct the air thus admitted in different predetermined directions relatively to the radius of the grinding mill chamber and thereby to vary the character of air currents within the separating chamber and regulate the action of the air separator.

Melting furnace. CHAUNCEY E. FRAZIER. U. S. 1,675,542, July 3, 1928. A melting furnace of twin construction adapted to carry in its lower portion the material under treatment and in its upper portion a heat-giving gaseous stream and including melting and working chambers arranged side by side, the furnace being provided with a port at the downstream end of the melting chamber, and means for diverting through the port a portion of a gaseous stream flowing through the furnace.

Forming and delivering charges of fictile material. ABIRAM A. OEFFNER. U. S. 1,675,906, July 3, 1928. Apparatus of the class described comprising a hopper, means for dropping a charge of material from a substantial height onto the bottom of the hopper, means for supporting a mold vertically below the hopper at such a distance that a charge falling from the hopper will acquire sufficient momentum to cause it completely to fill the mold, and means for suddenly opening the hopper to permit the entire charge to fall therefrom in the form of a dense swarm of discrete particles into a mold carried by the supporting means.

Supporting and exposing ceramic products in the course of their production. THEODORE C. AND WILLIS OSWALD PROUTY. U. S. 1,676,799, July 10, 1928. A device for supporting ceramic products and exposing the same to heat comprising a series of members positioned in relatively spaced order and constituting a rigid unitary structure affording a series of supporting surfaces arranged one above the other.

Vibrating apparatus for screening, sorting, drying, etc. A. KUHN. Brit. 285,638, Feb. 2, 1927. A W-shaped spring for supporting the vibrating frame in flexible relation to the fixed support is described. The supporting rod for the frame is secured to the center points of the W-springs. Springs of other shapes (*e.g.*, helical) may be used. (*B.C.A.*)

Kilns, Furnaces, Fuels, and Combustion

Tunnel kiln symposium. ANON. Amer. Refrac. Inst., *Tech. Bull.*, No. 23, May (1928).—Short descriptions of various kilns on the market are given by representatives of tunnel kiln builders. The Harrop kiln is described by HARTFORD as follows: The brick are set directly from the dry press to the kiln cars, which go directly down into a kiln car brick drier. The brick are in the drier 20, 24, or 30 hours, depending on the car schedule in the kiln; as soon as the brick come out of the drier the kiln cars are immediately transferred to the tunnel kiln in order not to lose the heat put in during the drying process. The size of the tunnel kiln is about 395 ft. in length, 5 ft. 8 in. in width and about $5^1/_2$ ft. in height, inside dimensions. The crown has a rise of about $7^1/_2$ in. Approximately midway of the length of the kiln there are seven furnaces on each side opening directly into the tunnel through large mouths. The last two mouths on each side are at a little lower elevation than the first five mouths to give even distribution of heat throughout the setting. They introduce the heat at a lower position on the setting than the first five furnaces. As the brick leave the fire zone, they pass on down into the cooling end where they are met by cooling air, which has been introduced at the far end of the kiln. This air is introduced directly into the tunnel, passes through the brick (picking up heat), and passes through the fire zone, in some cases helping to support combustion where flames come out of the furnaces. Then it passes on down through the charging end in order to provide preheating. Just past the fire zone openings through the kiln walls let out some of this air, because all of the air put in for cooling at the discharging end is not needed through the fire zone and in the charging end. Air from the relief ports is conducted to the dry-press drier located immediately after the dry-press machine. All the heat for the drying comes from relief ports. Therefore, the kilns supply not only all the heat for firing but all the heat for drying. In firing refractories, the kiln should be just as simple as possible and still have all the

adjustments on it to take care of any situation that may arise due to the peculiar characteristics of the clay. There are 2 ways of firing in an open-fire kiln, (1) to fire entirely in the tunnel by working the furnaces, and (2) to complete the combustion in the furnaces, dilute with excess air and wash the heat out into the tunnel immediately with the excess air. Either way gives the volume necessary to take care in heating up the brick in the charging end. The Rusell tunnel kiln is described by A. O. SCHLEIFFARTH as follows: The Russell tunnel kiln is a direct-fire kiln. For firing refractories, fire boxes are placed on each side. The direction of the gas combustion is toward the center of the kiln and can be taken out through side ports in the walls throughout the length of the preheating zone, thus giving proper regulation of the heat curve. Air for cooling the brick enters through the discharging end of the kiln through an arch on top of the main arch of the kiln. This air can be deflected downward into the body of the kiln or can be carried over the top of the main arch and out right at the end of the hot zone and then taken to the drier. About 80 gallons of oil are used per thousand 9-inch equivalents. It is a notable fact that whether 25,000 brick or 15,000 brick are run through the kiln, the amount of fuel oil used per day is about the same. This means that a tunnel kiln should be run up to its maximum capacity to get maximum fuel economy. Radiation losses are constant, no matter which way the kilns are run. The oil is 24°Bé. An Anthony type burner is used and the air for the burner preheated to a temperature of about 40°F. This is the primary air that goes through the burners. Heating the air aids in breaking up the particles of oil, giving better combustion conditions within the fire boxes. The Robertson tunnel kiln is described by H. M. ROBERTSON: At the Missouri Fire Brick Co. (Vandalia) this refractory kiln is 391 ft. long and 5 ft. wide inside. The cars are 7 ft. long, and loaded 5 ft. high. The kiln is designed for a daily capacity of 125 T. either of 9-inch straights or special shapes (about 34,000 or 36,000 brick). It is fired with raw producer gas. At the entrance end are alternate wide spaces on each side of the truck, about 2 ft. clearance, and narrow spaces $4^1/_2$ in., the principle being that heat will collect in the wide spaces and circulate through the load as the truck is opposite the narrow spaces. This means that every other truck length is a wide space. In the heating zone are seven fire ports on each side opposite one another and those fire ports are air cooled. The air used for cooling mixes with the gas of combustion when it enters the kiln and ignites. Opposite those fire ports on each side there is a long checkered bag wall. The combustion gases from the seven fire ports on each side are all collected and mixed back of this checkered wall and emerge through the openings in the wall into the load on the cars. The cooling zone of the kiln is entirely muffled by flues of fire clay and steel on both sides of the kiln. The cooling air is drawn through those flues not driven through by an exhaust fan. This air, of course, is used for drying or other purposes about the plant. The Miller tunnel kiln is described by R. H. MILLER: The class of material to be fired in a tunnel kiln has a great deal to do with its operation. Everything from split brick to tank blocks up to 700 lbs. in weight has been fired. In periodic kilns a large mass is set and the kiln heated up with the ware, but in a tunnel kiln conditions change every time a new car of brick is charged. This demands uniformity before the ware is charged in order to get uniform results. The first part of the heating is invariably on the top and the bottom is the last to heat up, so that the ware on the bottom has to undergo a different treatment than that at the top. Lack of preheating in the early stages is reflected when the brick come out of the kiln. At this plant all ware is fired in tunnel kilns. Certain classes of material go on the top; the remainder on the bottom. Anything that is made beyond the standard 9-inch brick is something special and belongs on the top because certain brick shapes will not carry weight. At the present time this kiln is seventeen courses high; eight high and greater width would be better. The kiln of the future will be low and wide rather than high and narrow, or perhaps a

square section. Whether or not there are baffles on the sides, the natural tendency is for drafts to follow the walls. The condition in the fire box is explosive, the gases expanding, so they fill all the spaces. The combustion gases are reduced in volume, due to several conditions, such as lowering of temperatures, moisture that they have picked up from the ware, etc., until they represent something that has to be pulled along. A shell condition is immediately created. The following subjects were discussed at the symposium: (1) fuel consumption of the various kilns, (2) time required for complete firing, (3) the use of tunnel kilns in firing dry-press brick and stiff-mud brick, (4) cost of constructing the various types of kilns, (5) labor saving in the use of tunnel kilns, (6) kiln schedules for various types of ware, (7) life of car-top blocks, (8) fuel consumption as influenced by the quantity of material produced, (9) determination of the most economical unit for a plant manufacturing a large quantity of brick, (10) the smallest tunnel kiln that can be built to produce refractories economically. F.P.H.

Flue-gas analysis in the ceramic industry. W. STEGER. *Ber. deut. keram. Ges.*, **9** [3], 175–82 (1928).—The object of analyzing the flue gases of ceramic kilns is of course to determine the completeness of combustion process and to obtain the maximum heat from a given amount of fuel. Various methods of analyzing the flue gases are described. Automatic flue-gas recorders based on chemical and physical methods of testing are listed and discussed. The installation and care of such appliances are considered. F.P.H.

Burning coal on underfeed stokers. J. G. WORKER. *Blast Fur. Steel Plant*, **16** [6], 784–86 (1928).—Chemical and mechanical features involved in combustion as attained in the underfeed stoker are discussed. F.P.H.

Tables for determining specific gravity and heat of gases. FRED M. REITER. *Gas Age-Rec.*, **61** [14], 469–71 (1928).—Heat values and specific gravities are often calculated from gas analysis. A table is given for calculating heat values in B.t.u. per cu. ft., and is designed for coal and other manufactured gases. To be used for natural gas, whose hydrogen and carbon monoxide content is very small but whose methane content may run as high as 95%, the table would have to be extended to the necessary values. F.P.H.

Cottrell electrical precipitation processes. N. W. SULTZER. *Gas Age-Rec.*, **61** [15], 505–506 (1928).—At the present time Cottrell equipment for detarring combustible gas is installed in or under construction in 41 plants. A thorough description of the equipment and operation is given. F.P.H.

New turbine type gas burner developed in Germany. ANON. *Gas Age-Rec.*, **61** [15], 510 (1928).—A description is given of the Eickworth turbine burner. Tests showed that the burner gave perfect combustion against furnace back pressure. It is suitable, also, for shaping furnaces, annealing furnaces, boiler, etc. Since it draws in the air required for the various volumes of gas automatically, attention is limited entirely to the adjustment of the gas valve. The burner is operated by the pressure of the gas, so that the energy otherwise required of air fans, gas compressors, etc., is eliminated and saved. Since the air or gas compressor, pressure and mixing regulators, safety devices and CO_2 indicators, and recorders are not necessary, this Eickworth turbine burner represents a simplification of combustion accessories. During several tests made on a heating furnace fired with coke-oven gas it was showed that the burner can be adjusted as desired between 3531 and 10,594 cu. ft. per hour and thereby maintain a constant good combustion. The flame was short and hot due to the fact that the air-gas mixture had been thoroughly mixed and whirled. F.P.H.

Cleaning bituminous coal. J. R. CAMPBELL. *Min. and Met.*, **9** [258], 279 (1928).—This 31 page pamphlet was originally written to indicate to users of coal and coke

the advantages to them of using cleaned coal, and it emphasizes the following fundamentals in the mechanical cleaning of bituminous coal: (1)necessity for washability studies, (2) type of plant adaptable to coal studied, (3) plant control and performance, (4) cost of washing. Results of a series of washability studies and methods of washing coal are discussed. Different methods in use in this country are described, such as methods of drying, sludge recovery, and water clarification, washing efficiencies, the cost of washing, effect of washing, and the results of washing on working plants. F.P.H.

Technical questions regarding transmission of gas over long distances. F. BAUM. *Stahl u. Eisen*, **48** [6], 161–71 (1928). F.P.H.

Advantages of new gas producer. ANON. *Amer. Glass Rev.*, **47** [39], 21 (1928).—An announcement has been made of the introduction of a new gas producer by the Dover Boiler Works, New York. It is in advance of current practice in the low cost gasification of very cheap fuels. The grates have no perforations through which extremely fine fuel can be wasted and the elimination of water seals makes it practicable to carry blast pressures of several pounds if necessary to overcome the resistance of small fuels. A half pound of hot gas can be maintained at the burners without having to cool, boost, and reheat the gas. Waste heat in the water jackets generates the steam for making the gas, saving a dollar or more per ton of fuel gasified. Efficiences up to 93% are obtained by this conservation of heat and labor economies are effected because clinker will not build up on the smooth water-cooled steel walls. There are no moving parts in the fuel feed. E.P.R.

Conservation of fuel by the insulation of high temperature installations. ANON. *Refrac. Jour.*, **3** [28], 678–79 (1928).—A thorough discussion of the manner and advantages of insulating kilns is given. E.P.R.

Kilns and fuels for refractories. W. E. RICE. *Refrac. Jour.*, **3** [28], 682–86 (1928).—Classifying by methods of firing, we may say there are three type of kilns: (1) those in which the relative position of the fires and ware is stationary and firing periodic (this is illustrated by the periodic kilns); (2) those in which the ware is stationary and the position of the fires movable (illustrated by the continuous compartment kilns); (3) those in which the fires are stationary and the ware movable, as in the railroad car-tunnel kilns. The types of particular interest to manufacturers of refractories are the periodic and the railroad tunnel kiln. Three general types of furnace are used for burning coal in these kilns: (1) the dead-bottom furnace having no grates and may or may not have an intermediate arch, which helps to support the bed of fuel; (2) the sloping-grate furnace, the angle made by the grate bars with the horizontal varies from 30–60° in different kilns, and is a modification of the dead-bottom furnace; (3) the horizontal grate furnace, where the grate bars are somewhat movable. If relatively small amounts of coal are charged into alternate furnaces, with short intervals between firings (30–40 min.), and alternate furnaces only are cleaned at one time, a more constant rate of application of heat, saving of fuel and time, and a better ware produced, will result. About one-half of the air required for combustion must pass through the bed of fuel; the remainder is admitted as secondary air over the bed. At some plants the air opening is as low as 25% of the area of the grate, whereas with narrow grate bars the air openings may easily be made 60% of the area without greater loss of combustible in the ash. Natural gas and oil are fired through small openings in the wall of the kiln, preferably near the floor. Combustion takes place within the enclosure formed by the bag wall. The height of the wall is important and is governed by the fuel used, the kind of ware to be fired, the manner of setting the ware in the kiln, and the draft available. There are two types of kiln floors, described as "solid" and "open." On the solid floor the ware is likely to be over-fired near the bottom

and under-fired near the walls; on an open floor the ware is more likely to be fired uniformly. Natural draft is provided by a chimney, which must provide a sufficient draft to overcome the combined resistances of the grates, bed of fuel, setting, floor, flues, and chimney, and to move the weight of gases required to produce the desired condition during each period of the firing cycle. The following proportions give good results in periodic kilns: Take the total area enclosed by the walls as 100%; then the area of the grates should be 12.5%, the total area of the openings in the floor, 3.5–5%, the area of the main flue, 1%, the area of the chimney, 1%, and the height of the stack 35–40 feet. There are two types of tunnel kiln; the direct-fired car-tunnel kiln which is operated at less expense than the muffle type; and the muffle type railroad car-tunnel kiln which is similar, in general construction, to the direct-fired, but here the interchange of heat is accomplished by the recuperative system and the products of combustion never come in contact with the ware. E.P.R.

Firing technique and heat technology. H. STÜMBKE. *Keram. Rund.*, **36**, 283–87 (1928).—Brief abstracts of papers in German, French, and American journals on furnaces, fuels, gas producers, firing methods, heat balances, and sources of heat losses are given. H.I.

Composition of petroleum and its products. GEORGE A. BURRELL. *Ind. Eng. Chem.*, **20** [6], 602–608 (1928).—This paper discusses briefly some of our present knowledge of a few of the important phases of petroleum chemistry, including the composition of raw petroleum and that of its cracked products. It is written in part to show the scantiness of that knowledge and the great need for more research work. The questions of the composition of natural gas, of the light and lubricant fractions of petroleum, of the asphaltic portion, and of the sulphur, nitrogen, and oxygen compounds are discussed. Attention is also called to the newly discovered sweetening reactions, to petroleum by-products, and to the diolefins, gum, and color in cracked gasolines. Particular stress is laid on the need of research in analytical chemistry to develop methods of identifying the compounds in petroleum and its products. R.J.P.

Measurement of producer gas mixtures in conduits under low pressures. G. WÜNSCH. *Glastech. Ber.*, **5** [4], 145–54 (1927).—A discussion of the various methods and apparatus used for measuring the pressure and quantities of gas mixtures (containing tar, dust, and water), in conduits or channels under pressures below 10 mm. water column. E.J.V.

Chemical study of processes involving the carbonization of coal by internal heating. M. W. TRAVERS. *Glass*, **5** [2], 70 (1928).—T. gives a detailed discussion, with calculations, of the amount of heat required to carbonize coal at 600°C. The low temperature carbonization of coal by superheated steam and the manufacture of water gas from coal are also considered. A.J.M.

Modification of the Thomson mixture for the determination of the calorific power of coals. MAURIZIO COUTURE. *Atti II congresso naz. chim. pura applicata*, pp. 1374–75 (1926).—With the usual mixture of 2 g. of coal and 18 g. of KNO_3–$KClO_3$, combustion is so rapid (17–20 min.) that serious losses occur. A greater quantity of KNO_3–$KClO_3$, does not prevent all loss, and with a smaller quantity of coal combustion is incomplete and irregular. Excellent results are, however, obtained if 1 g. of coal, 1 g. of NH_4NO_3, and 18 g. of KNO_3–$KClO_3$ mixture are used, combustion being complete in 30–35 min. (an ideal length of time) and the results agreeing closely with those by the Mahler methods. As in the ordinary 2-g. method, 10% is added in the calculations. The factor 0.54 corresponding to the NH_4NO_3 is then subtracted according to the directions of Salvadori (cf. *Gazz. chim. ital.*, **36** (1906)). (*C. A.*)

Electrical precipitation in the manufactured gas industry. H. M. PEIR. *Gas Age-Rec.*, **59**, 705–707 (1927).—The Cottrell process as applied to the removal of tar and vapor from manufactured gas is described. (*C. A.*)

Removal of dusts and mists from gases by electrical precipitation. C. HAHN. *Gas. u. Wasserfach*, **71**, 269–76 (1928).—Electrical precipitation is contracted with other methods of removing dusts and mists from gases, and modern plants are described and illustrated. Among the special uses of electrical precipitation are the removal of coal dust from air used to dry coal or lignite, separation of ashes from flue gases in powdered-fuel-burning installations, removal of dust from hot producer gases and tar from cool gases, dusts from all types of milling operations may be collected, dust from sulphur-burner gases and acid fogs may be collected, blast furnace gases may be freed from dust (it is said that several such installations are being made and that all requirements for the use of blast furnace gas have been satisfied). Moist air used in textile mills may be freed from fibers and dust and recirculated. In one briquetting plant 300 T. of coal per week were recovered and in a cement plant 70 T. of cement in a week. (*C. A.*)

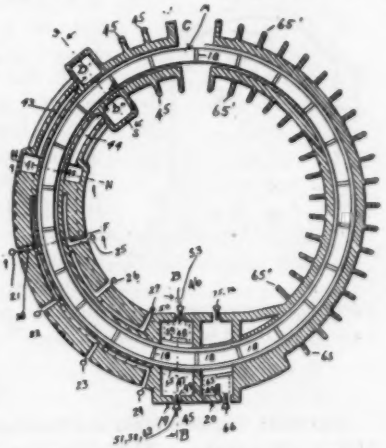
PATENTS

Combined drying and firing kiln. HALVER R. STRAIGHT. U. S. 1,657,138, Jan. 24, 1928. In a device of the class described, a series of drying kilns and a firing kiln arranged in common alignment, the drying kilns being slightly spaced apart, the firing kiln being arranged adjacent to the outer end of one of the drying kilns, means for conveying ceramic ware through all of the kilns, means for delivering plastic ware to the conveying means, at the outer end of one of the drying kilns so that the conveying means may be partially loaded, and means for delivering plastic ware to the conveying means at a point between two adjacent drying kilns so that the conveying means may be completely loaded.

Apparatus for treating gases. EUGEN STRÖDER. U. S. 1,663,734, March 27, 1928. Apparatus of the class described, comprising a housing, a liquid container within the housing, a spraying device consisting of two shafts carrying disks spaced in parallel relation and partly immersed in the liquid of the container, means for passing gas through the housing above the disks parallel to the shafts and means constructed and arranged to prevent the return of liquid acted upon by the gas to the container.

Tunnel-kiln car and method of loading ware thereon. GEORGE D. MORRIS. U. S. 1,674,836, June 26, 1928. In a kiln car, a ware supporting superstructure comprising a permanent arrangement of slabs and posts and a removable post having ware-supporting means coöperating with the permanent structure for directly supporting ware to be heat treated.

Oven for firing refractories, etc. HEINRICH KOPPERS. U. S. 1,674,985, June 26, 1928. A continuously operating plant for firing fireproof material, comprising a plurality of firing chambers, a preheating chamber, and a plurality of cooling chambers, the preheating and cooling chambers being spaced from and operated independently of the firing chambers, and means for conveying material from the preheated chamber to the firing chambers and means for conveying the fired material from the firing chambers to the cooling chambers.



Circular kiln. THEODORE C. AND WILLIS O. PROUTY. U. S. 1,674,992, June 26, 1928. In a furnace of the class described a muffle, means for moving material therethrough, independently controllable sources of heat coacting with separate successive sections of the walls of the muffle.

Kiln bottom and method of building kilns. CLAUD E. FULLER. U. S. 1,676,182, July 3, 1928. In a structure of the kind described, the combination of a plurality of arches each of less length than the width of the structure and extending inwardly from either side thereof.

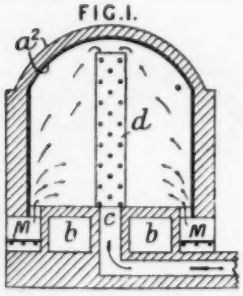
Rotary kilns for firing cement, ore, and similar materials. VICKERS, LTD., AND L. D. PARKER. Brit. 284,494, March 23, 1927. The kiln has its interior formed of a number of cylindrical portions inclined to the general axis of the kiln joined by cylindrical portions not inclined to, but eccentric to, the axis, so that a longitudinal section is wavelike.

Burning of oil fuel. J. E. HACKFORD. Brit. 284,777, Feb. 18, 1927. Oil fuel is burnt without atomization by passing a steady stream of air over a concave surface (a cup or trough) which is covered with a thin film of the oil, the oil being fed to the surface at such a rate as to maintain this film. Means are provided for varying the heat intensity of the flame by adjusting the direction, etc., of the air current. In its simplest form the apparatus consists of a cup into which the oil is allowed to drip from a gravity feed. (*B.C.A.*)

Purification of furnace gases. C. V. A. ELEY. Brit. 285,544, Nov. 15, 1926. The discharge of smoke or noxious gases from furnaces is reduced or eliminated by passing the gases successively through a filter chamber and a tank. The filter chamber may be provided with trays containing chemical reagents for purifying the gases, or may contain a spray for supplying water or other liquid for the same purpose. The gases enter the tank below the level of the liquid and may be made to pass below a baffle plate attached to the inlet pipe before passing up through the liquid and escaping. The tank is provided with a sump containing a helical conveyer for the removal of deposited solid matter, which passes through a valve into a chamber from which it can be removed from time to time. (*B.C.A.*)

Tunnel ovens. J. WILLIAMSON. Brit. 287,623, May 16, 1928. In a continuous tunnel oven of the direct flame type in which the gases from the firing zone are employed to preheat incoming goods indirectly, *i.e.*, without actual contact with the goods, there is provided, in connection with side flues for taking off the gases from the firing zone, a system of dampers by which the course of the flame through the goods can be varied in the longitudinal and transverse directions.

FIG. 1.



Pottery kilns. F. BENNION, H. J. PLANT, AND J. B. CLARKE. Brit. 287,693, May 16, 1928. In a kiln or oven for firing pottery and other ware having fire-places around its base the heating gases are exhausted to the outlet flue through a perforated or slotted pipe which extends to, or nearly to, the roof of the kiln chamber. Some of the heating gases leaving the kiln may be passed through floor flues.

Ceramic kilns. A. J. COULHON. French 617,468, June 12, 1926. An auxiliary kiln is provided outside an ordinary ceramic kiln, and from it hot gases are passed through conduits controlled by dampers into the kiln chambers. Where several kilns are in operation, the waste heat from one may be used to preheat another. The arrangement enables the ware to be dried within the chambers and it facilitates cooling. (*B.C.A.*)

Geology

Brownian displacements and thermal diffusion of grains suspended in a nonuniform fluid. S. CHAPMAN. *Proc. Roy. Soc.* (London), **119(A)**, No. A781, 34–54 (1928).—The distribution in magnitude and direction, in any assigned interval, of small spherical

grains suspended in a fluid, liquid or gaseous, is obtained for the general case where the fluid is nonuniform in temperature, composition, or any other property which affects the coefficient of diffusion of the grains. The steady distribution of grains in a fluid is determined when the temperature of the fluid is nonuniform, both when the grains are of the same density as the fluid and when there is a difference in density, so that the grains are acted on by differential gravity. In liquids or in gases other than a Maxwellian gas the grains are most concentrated in the coldest regions. H.I.

The formation of humus. G. V. JACKS. *Chem. and Ind.*, **47,** 623 (1928).—Lignin is the chief humus former. All natural humic acids contain considerable quantities of a reducing agent that gives the reactions of glycuronic acid. Artificial humic acids do not contain this acid. Iron appears to play a fundamental rôle in humification. Both ferrous and ferric iron were found, organically combined, in natural humic acid. Lignin will not humify unless it contains iron. H.H.S.

Potash in Russia. ANON. *Chem. and Ind.*, **47,** 643 (1928).—The shafts sunk by the Soviet Potash Trust at Solikamsk are estimated to produce 90,000 T. of fertilizer salts during 1928, and it is hoped to produce 500,000 T. during 1929. H.H.S.

Potash in New Brunswick. L. H. COLE. *Chem. and Ind.*, **47,** 676 (1928).—While drilling wells for oil and gas at Gautreau, N. B., salt beds were found containing 0.66% K. The minerals are probably polyhalite, kainite, and carnallite. H.H.S.

The borax industry: kernite. W. T. SCHALLER. *Science Supp.*, **67,** (April 13) 10 (1928).—Exploitation of the kernite (also called rasorite) deposits in the Mohave Desert, Kern Co., Calif., may result in a complete U.S. monopoly of borate mining. So far as is known, the new mineral discovered in 1926 exists nowhere else in the world. It is $Na_2B_4O_7 \cdot 4H_2O$, and during refining from its only impurity, clay, it takes up 6 mols H_2O, so that one ton of kernite makes 1.4 T. of borax. H.H.S.

The nature of clay and its significance in the weathering cycle. G. W. ROBINSON. *Nature*, **121** [3058], 903 (1928).—R. believes that the iron in clays is present as an essential part of the clay. The primary residual product of the chemical weathering of silicates is a mixture of kaolinite ($Al_2O_3 2SiO_2 2H_2O$) and nontronite ($Fe_2O_3 2SiO_2 2H_2O$) or of hydrated silicates having the same silica to sesquioxide ratio (2:1). Variation in this ratio may be due to the removal of the sesquioxides by leaching. The precipitation of dissolved silica from river water, when it comes in contact with the salt water of the sea, raises the silica content of littoral and estuarine clays. C.R.A.

Mineral industries of New England. OLIVER BOWLES. *Min. and Met.*, **9** [258], 261–62 (1928).—Mineral production of New England for 1925 is given. F.P.H.

Mining diaspore and flint fire clays in Missouri. H. S. MCQUEEN AND C. R. FORBES. *Min. and Met.*, **9** [258], 271–75 (1928). F.P.H.

A study of bauxite. T. V. M. RAO. *Mineralog. Mag.*, **21** [120], 407–30 (1928).—The study of bauxite is summarized as follows: (1) The process of lateritization consists of the action of alkali carbonates on the aluminum silicates of rocks, when hydrated aluminum carbonate is formed; this compound being unstable breaks down into dydrated aluminum oxide, which is deposited in the form of bauxite. This together with the undecomposed minerals of the rock, forms laterites. (2) Bauxite is a definite mineral having a composition corresponding to a dihydrate of alumina. (3) The gibbsite present in laterites is of secondary origin formed by hydration of bauxite. (4) Diaspore never occurs in laterites, as mere conditions of lateritization are not sufficient for its formation. (5) Feldspar, micas, cyanite, tourmaline, hematite, magnetite, limonite, pyrite, ilmenite, rutile anatase and sphene, some of primary and others of secondary origin, have been definitely found to occur in laterites F.P.H.

The structure of feldspar and micas. MIECZYSLAW DOMINIKIEWICZ. *Roczniki Chem.*, **7,** 345–56 (1927).—Structural diagrams are given showing the kaolin nucleus as a fundamental constituent of feldspar and micas. Anorthite is regarded as normal Ca

kaolinate. The SiO_2 split off in the course of kaolinization of feldspar is combined with the Al and not with the SiO_2 part of the kaolin nucleus. Part of the K_2O is combined with this SiO_2. Orthoclase is K-kaolinate-silicate; the 8 aluminate complexes of the 2 natrolite radicals are saturated with 2 mols K silicate. The possibility of structural isomerism is evident from the diagram. Kaolinization, whereby alkali silicate is split off and replaced by H, can be effected not only by hydrolysis but also by pneumatolysis (acid vapor, steam). The acid micas with a varying ratio of Al_2O_3:SiO_2 are products of gradual hydrolysis. They may also partly represent mixtures of normal and acid, or of different acid compounds. The simplest mica may be derived from a natrolite nucleus. Replacement of free SiO_2 radicals by F, Mg, or both leads to lepidolite, the simple biotite, or phlogopite. Other biotites may be substitution products of the natrolite and kaolin nucleus, the aluminate part of which is combined with Mg silicate. (*C. A.*)

BOOKS

Preliminary Report on an Investigation on the Treatment of Certain Western Clays to Overcome Drying Defects. H. FRECHETTE AND J. G. PHILLIPS. Ceramics Division, Mines Branch, Department of Mines, Ottawa, Canada. Reviewed in *Can. Chem. Met.*, **12** [7], 204 (1928).—Following attempts to produce high-grade face brick in Manitoba, a study of the problem was made by the Mines Branch. The tendency to crack was very great in these clays, and preheating proved the only effective method of treatment. Preheated to 800 and 950°F, the clays showed decidedly improved properties. The control of this temperature range in a large plant presents a problem in commercial production. E.J.V.

Silica in Canada. II (Western Canada). L. H. COLE. Canada Dept. of Mines, *Publ.*, No. 686, 59 pp. Ottawa: F. A. Acland, 1928. Part I, published in 1923, dealt with the occurrence, exploitation, and uses of silica in eastern Canada. The present volume deals in the same way with western Canada, but carries an appendix covering recent developments in the East. Chapter I describes structural and geological features in which possible commercial deposits occur, and Chapter II the discovered deposits. (Illustrated). Reviewed in *Can. Chem. Met.*, **12** [7], 204 (1928). H.H.S.

Chemistry and Physics

Photomicrography in natural color. THOMAS S. CURTIS. *Jour. Amer. Ceram. Soc.*, **11** [8], 609-32 (1928).—An outline of the processes and technique used in the Vitrefrax Laboratory for the preparation of permanent and faithful records of ceramic and refractory body structures.

The colloidal behavior of lime. K. W. RAY AND F. C. MATHERS. *Ind. Eng. Chem.*, **20** [5], 475–77 (1928).—There has been a theory advanced that the plasticity of hydrated limes is due to the presence of irreversible colloids. A quicklime slaked to a wet putty has different properties from a putty made by soaking a dry hydrate. This is explained by the theory that in making the dry hydrate the colloids are destroyed. The work of R. and M. proves the presence of charged or colloidal particles in a lime putty and shows that there are more colloids in a putty made from plastic hydrated limes than in one made from the nonplastic limes. It was found that plastic lime putties exhibit cataphoresis to a limited extent and that the amount of cataphoresis differs with different lime putties and seems to be somewhat related to the plasticity of the lime putty. Putties made from quicklimes slaked with excess water show marked cataphoresis while putties made from nonplastic hydrates never show cataphoresis. A theory is advanced to explain the mechanism by which the colloids effect plasticity. R.J.P.

Equilibria in the reduction of ferric oxide. C. C. FURNAS AND G. G. BROWN. *Ind. Eng. Chem.*, **20** [5], 507–10 (1928).—New thermal data on ferric oxide have been

used with other data in the literature to compute, by means of the third law of thermodynamics, the equilibrium constants of reactions involving the reduction of ferric oxide. The results so obtained have been compared with experimental results obtained by other investigators. R.J.P.

Total carbon in coal. A. R. CARR AND A. M. RENTE. *Ind. Eng. Chem.*, **20** [5], 548–49 (1928).—A method has been devised which is simpler and requires less expensive apparatus than the usual method of determining carbon in coal. A detailed description of the apparatus and the method employed is given. R.J.P.

Fusion of coal, coke, and motor fuel by sodium peroxide. GEORGE E. MABEE. *Ind. Eng. Chem.*, **20** [6], 644–45 (1928).—In the sodium peroxide method for fusing coal and coke to determine sulphur M. recommends fusion in a muffle furnace dispensing with benzoic acid and potassium chloride. This gives a more complete fusion and eliminates the possible danger from potassium chlorate. In the fusion of motor fuel advantage is taken of the spontaneous ignition of the primary alcohols with sodium peroxide in order to start the fusion without the use of a hot iron rod or wire. R.J.P.

Changes in the chemical industry during the past 25 years. ANNA HAZEL SWIFT. *Ind. Eng. Chem.*, **20** [6], 657–62 (1928).—A somewhat detailed review of the chemical industry during the past 25 years with many tables of data from government records. R.J.P.

An improved glass manometer. FARRINGTON DANIELS. *Jour. Amer. Chem. Soc.*, **50** [4], 1115–17 (1928).—A device for measuring the pressure of a gas enclosed entirely in glass is described. A measured air pressure is balanced against the pressure of the enclosed gas through a glass diaphragm and the point of balance is obtained by closing an electrical circuit through a platinum contact fused to the diaphragm. Although similar to earlier devices the apparatus described is more reliable and easier to construct. R.J.P.

Perfects electroplating methods. ANON. *Abrasive Ind.*, **9** [7], 192 (1928).—A preparation has been invented which, when applied to any material, makes that material electrically conductive. Practically any metal can thus be deposited on any material. E.P.R.

Optical apparatus for measuring small changes in length in testing materials. W. KÖHLER. *Centralblatt der Hütten u. Walzwerke*, **31** [25], 338–41 (1927).—A discussion of methods of operation, construction, sensitivity, gaging, and limits of error of optical measuring apparatus, as used for measurement of changes in length. E.J.V.

Entry of lime into the system of materials present in metallurgical slags. E. DIEPSCHLAG AND H. FLIEGENSCHMIDT. *Centralblatt der Hütten u. Walzwerke*, **31** [39], 551–56; [40], 567–72; [41], 582–90 (1927).—D. and F. determined the effect of lime in a system containing the materials present in a slag. E.J.V.

German soda ash factories reorganize. ANON. *Glass Ind.*, **9** [7], 153 (1928).—The former syndicate of German soda ash and caustic soda factories (Ltd.), of Bernburg, contolling soda ash and caustic soda, was liquidated under its title "Deutsches Soda-und Aetznatron Syndikat G.m.b.H.," but was immediately reorganized into two syndicates. One "Syndikat deutscher Sodafabriken G.m.b.H.," controls calcined and crystal soda ash and bicarbonate, while the other, "Syndikat deutscher Aetznatronfabriken G.m.b.H.," covers caustic soda, solid and liquid. E.J.V.

Crystal structure of the chrondrodite series. W. H. TAYLOR AND J. WEST. *Proc. Roy. Soc.* (London), **117 (A)**, No. A777 (1928).—The crystal structures of three members of the chrondrodite series, chrondrodite ($H_2Mg_5Si_2O_{10}$), humite ($H_2Mg_7Si_3O_{14}$), and clino-humite ($H_2Mg_9Si_4O_{18}$) were studied by means of X-rays in the rotating crystal method. The three structures consist of alternate layers (parallel to the *c* face) of $Mg(OH)_2$ and Mg_2SiO_4 based on an arrangement of oxygen atoms and OH groups in

hexagonal close packing. The oxygen atoms appear to determine the dimensional relations of the unit cells while the Mg and Si atoms appear to control the pattern and herefore the cell symmetry. The Mg_2SiO_4 portion possesses the olivine structure. While the $Mg(OH)_2$ layer maintains the same thickness in all the crystals, that of the olivine layer (measured perpendicular to the *c* face) has the ratio in chrondrodite, humite, and clino-humite of 2:3:4 respectively, corresponding to the formulas $Mg(OH)_2 \cdot 2Mg_2SiO_4$, $Mg(OH)_2 \cdot 3Mg_2SiO_4$, and $Mg(OH)_2 \cdot 4Mg_2SiO_4$. H.I.

The structure of cyanite, $Al_2Si_2O_5$. W. H. TAYLOR AND W. W. JACKSON. *Proc. Roy. Soc.* (London), **119 (A),** No. A781, 132–46 (1928).—The crystal structure of cyanite was determined by means of a qualitative investigation based on X-ray photographs obtained by the rotating crystal method. There are four molecules in the unit cell, which is triclinic, with the following axial lengths and angles: $a=7.09$Å, $b=7.72$Å, $c=5.56$Å; $\alpha=90°5\,1/2'$, $\beta=101°2'$, $\gamma=105°44\,1/2'$. The structure is based on a slightly distorted cubic close packing of oxygen atoms, the silicon and aluminum atoms being distributed in a uniform manner among the interstices of the oxygen arrangement in such a way that independent tetrahedral SiO_4 groups are formed, while each aluminum atom is at the center of an octahedral group of six oxygen atoms. The existence of densely packed atomic planes, separated by a wide spacing, parallel to (100), explains the existence of a very perfect cleavage parallel to this direction. In a similar way planes parallel to (010), densely packed with silicon and aluminum atoms and widely spaced, account for the less perfect but clearly marked (010) cleavage. The variation in hardness on the (100) face is explained as being due to the existence of this cleavage. H.I.

Thermal properties of minerals and ceramic bodies. WILLI M. COHN. *Ber. deut. keram. Ges.*, **9** [5], 239–99 (1928).—The recent literature on the thermal properties of minerals and ceramic bodies is summarized. The various methods used in determining the thermal properties of the materials are described. There are 178 citations to the literature on this subject. The data are summarized in table and graph form and the temperature interval, method of investigation, and name of investigators are given. The data are given in tables. F.P.H.

Separating and determining iron, alumina, and manganese in cement. G. SOZZETTI. *Le Industrie del Cemento*, **25,** 9 (1928); *Tonind. Ztg.*, **52** [20], 385 (1928).—New methods for separating and determining iron, alumina, and manganese in cement are described. F.P.H.

Microscopic investigation of raw materials and products. ANON. *Keramos*, **7** [7], T6 (1928).—A discussion is given of the various applications of the microscope in the ceramic industry. Equipment such as microscopes, thin section machines, and other accessories are described and illustrated. F.P.H.

Use of triaxial diagrams in ceramics. W. SCHUEN. *Tonind. Ztg.*, **52** [28], 543–46 (1928); *Rock Prod.*, **31** [12], 88 (1928).—S. described how triaxial diagrams can be used to show the usefulness of various materials. An excellent review of the chemical processes involved in the ceramic industry is given. Of particular interest is the illustration showing the triaxial position of Portland cement, alumina cement, blast-furnace slag, clay, porcelain, stoneware (vitreous), and Chamotte stone. F.P.H.

Cohesion: a general survey. C. H. DESCH. *Trans. Faraday Soc.*, **24** [2], 53–64 (1928).—D. discussed the following phenomena which depend on the nature of cohesion: (1) The tenacity of metals, of crystals such as rock salt, and also of glassy substances, as determined by a tensile test, is very much less than that calculated from physical theory. (2) The so-called elastic limit is not a physical constant. The more delicate the extensometer used the lower the stress at which permanent deformation is seen to begin. Single crystals appear to yield at the lowest stress which can be applied in a testing machine. (3) Failure by fatigue, *i.e.*, by repeated applications of stress,

occurs under much lower ranges of stress than that required to produce failure under static leading. (4) The process of cold-working, or of deforming a solid at high temperature below some limiting temperature alters the properties of the material to a remarkable extent. (5) The manner of deformation depends to a great extent on the rate of application of the stress, and the time during which it is applied. (6) In bodies composed of many crystals, there is a marked difference between the properties of the interior of crystals and their boundaries which is imperfectly understood and this difference is of importance in relation to many facts of strength and fatigue. (7) The nature of crystal surfaces is of importance in the study of lubrication, where solid surfaces are separated by a thin liquid film, and in that of welding and sintering, in which surfaces are united by contact at temperatures below the melting point. (8) The problem of adhesives and solders, or materials, thin films of which can firmly unite solid masses, and that of the adhesion of coatings of foreign material deposited by electrolysis or other processes. (9) Diffusion can occur in solids, and is of importance in many technical processes. It is not certain whether it takes place by change of place of atoms in an undisturbed lattice, or whether previous loosening of the lattice is essential. The nature of cohesion and a mathematical expression based on Van der Waal's equation are also discussed. R.D.R.

Cohesion at a crystal surface. J. E. LENNARD-JONES AND BERYL M. DENT. *Trans. Faraday Soc.*, **24** [2], 92–108 (1928).—The cohesion between the outside particle, existing alone, unaffected by the presence of other free atoms or ions, and a crystal of rock salt was analyzed under the following headings: (1) the electrostatic field outside a crystal, (2) the polarization of a neutral atom in the electrostatic field of a crystal, (3) Van der Waal's cohesive forces, (4) the polarization of a crystal by a charge outside it. R.D.R.

Cohesion and related problems. ANON. *Trans. Faraday Soc.*, **24** [3], 165–81 (1928).—A general discussion of cohesion and related problems of interest to scientists and engineers is given. R.D.R.

Electrical conductivity of mica. J. M. MACAULAY. *Chem. and Ind.*, **47**, 654 (1928).—An account of researches on the curious fact that a freshly split surface of mica is a fairly good conductor of electricity, and that exposure to air gives it its well-known insulating properties. The late Lord Rayleigh first noted this phenomenon, and gave a partial explanation of it, which M. modifies. The conductivity of the fresh surface is excellent when the splitting is done in dry clean air, and M. suggests the temporary formation of a thin film of liquid air. H.H.S.

Sixth Colloid Symposium, Toronto. F. E. BARTELL. Preliminary Program, Univ. of Toronto, held June 14–16, 1928. The program contained 26 papers including "Adsorption of Methylene Blue by Lead Sulphate," by W. D. Bancroft; "Influence of Temperature on Coagulation of Colloid Solution," by E. F. Burton; "Charges on Colloidal Particles," by W. D. Harkins; "Stabilities of Emulsions," by J. C. Krantz and N. E. Gordon; "Study of Hydration Changes by Volume Change," by H. A. Neville; "Ultra-Centrifuge," by J. B. Nichols; and "Adsorption and Physical Character of Precipitates," by H. B. Weiser and G. E. Cunningham. H.H.S.

Accurate rapid mechanical analysis. G. J. BOUYOUCOS. *Science*, **67**, 587–88 (1928).—The hydrometer method has been studied for the determination of the 3 main groups of soil particles (sand, silt, and clay or colloids). An accurate result can be obtained readily by taking two readings of the hydrometer, one at the end of one minute and the other at the end of 15 minutes. The first settlement gives the sand, the second the silt. Fine silt by this method goes with the clay. The hydrometer, with the aid of Stokes' law, can be used to make very detailed mechanical analysis. H.H.S.

The thermal decomposition of the hydrates, nitrates, and oxide of aluminum. N. PARRAVANO AND G. MALQUORI. *Atti II congresso naz. chim. pura applicata*, pp. 1131–34

(1926).—$Al(NO_3)_3 \cdot 6H_2O$ is formed when $Al(NO_3)_3 \cdot 9H_2O$ is maintained at ordinary temperature over P_2O_5 *in vacuo*, or by repeated treatment of $Al(NO_3)_3 \cdot 9H_2O$ with hot $HNO_3 \cdot H_2O$. $Al(NO_3)_3 \cdot 6H_2O$ has already been prepared in other ways (cf. Inamura, *Mem. Coll. Sci. Kyoto*, **4**, 105 (1919)). A new *hydrate*, $Al(NO_3)_3 \cdot 4H_2O$, was prepared by maintaining $Al(NO_3)_3 \cdot 6H_2O$ in contact with excess N_2O_5 at ordinary temperature for 12 hours. It remains unaltered up to 180°, at which temperature it decomposes to Al_2O_3, N_2O_5 and H_2O. The thermal decomposition curve of $Al(NO_3)_3 \cdot 9H_2O$ showed breaks at 73.5°, 140°, and 200°, corresponding to fusion and conversion to $Al(NO_3)_3 \cdot 6H_2O$, to decomposition of the latter to the *basic salt*, $4Al_2O_3 \cdot 3N_2O_3 \cdot 14H_2O$, and to decomposition of the latter to Al_2O_3. The curve of $AlCl_3 \cdot 6H_2O$ showed breaks at 122° and at 180°, the latter corresponding to decomposition of Al_2O_3. $Al_2(SO_4)_3 \cdot 18H_2O$ behaves differently. At 105° it becomes anhydrous and at 760° the $Al_2(SO_4)_3$ decomposes to Al_2O_3 and SO_3. Samples from various sources of Al_2O_3 containing different proportions of H_2O of hydration were then heated, and the curves were compared with those of gibbsite, diaspore, and bauxite. The results were complicated and difficult of interpretation but indicate that the breaks in the curve which were observed were caused (1) by the formation of lower hydrates of definite chemical composition and (2) by adsorption phenomena. (*C. A.*)

The crystallization of lead oxide-silica glasses. FELICE DE CARLI. *Atti II congresso naz. chim. pura applicata*, pp. 1141–45 (1926).—The system PbO–SiO_2 was studied by a method already described (*C. A.*, **20**, 1963), temperatures up to 1300° being used. The results are shown in tabular and diagrammatic form. Temperatures of devitrification correspond to the zone of maximum velocity of crystallization and furnish data which are more precise than those of the beginning of crystallization, which are too much influenced by supercooling (cf. Hilpert and Nacken, *C. A.* **5**, 40). The data obtained allow the construction of a diagram of state showing the individual compounds and the zones of concentration corresponding to mixtures having the maximum tendency to devitrify and therefore to be avoided as components of smelts. At the maximum points of the diagram the velocities of devitrification are much greater than at the minimum points, and while in the former case abundant crystallization occurs in a short time, in the latter case traces of crystallization appear only after several days. The results confirm the existence of the ortho- and metasilicate and also show the existence of the compound $PbO \cdot 2SiO_2$. Contrary to Hilpert and Nacken (*loc. cit.*) there was no evidence of the compound $3PbO \cdot 2SiO_2$. Mixtures containing 100–90%, 85–80%, and 76–72% PbO are the most readily fusible, with the least tendency to devitrify. $PbO \cdot SiO_2$ has a maximum velocity of devitrification around 1000° where the glass has hardly begun to soften. (*C. A.*)

Glasses from sodium metaphosphate with oxides of lead, cadmium, and manganese. FELICE DE CARLI. *Atti II congresso naz. chim. pura applicata*, pp. 1146–50 (1926).—The systems $NaPO_3$–PbO, $NaPO_3$–CdO, and $NaPO_3$–MnO were studied by determining the temperatures of devitrification by a method already described (*C. A.*, **20**, 1963). Mixtures rich in PbO are crystalline and yellow; toward 60% PbO they are still crystalline but are white, and below 50% PbO the fused products do not crystallize but form vitreous masses soluble in warm very dilute HNO_3. A diagram shows a maximum at 950° with separation of the compound $NaPbPO_4$. Above this per cent $NaPO_3$ the temperature of devitrification decreases rapidly to 600°, then increases with the separation of the compound $Na_2PbP_2O_7$, then decreases to a minimum at 350° and finally increases to 600° for $NaPO_3$. Between 650° and the eutectic the curve changes its slope abruptly at the point corresponding to the compound $3NaPO_3 \cdot PbO$ (cf. *Z. anorg. Chem.*, **9**, 229 (1895); **12**, 444 (1896)). CdO dissolves with difficulty in $NaPO_3$ and no data were obtained above 40% CdO. The glasses are colorless and devitrify readily,

and the diagram is similar to that of PbO–$NaPO_3$. The minimum is at 380° and the maximum at 580° for a mixture containing 37% CdO. In this zone the reactions of $H_4P_2O_7$ are positive. MnO gives glasses of a dark violet color, which easily devitrify with formation of violet crystalline masses. Because of the infusibility of MnO, mixtures rich in the latter could not be prepared. Qualitative tests proved the separation of a mixed pyrophosphate and a mixed orthophosphate. The results show that $NaPO_3$ forms orthophosphates and metaphosphates with metallic oxides, and that glass beads owe their colors to the formation of pyrophosphates. (*C. A.*)

A new method for the micro-determination of arsenic. HANS KLEINMANN. *Deut. Z. ges. gericht. Med.*, **11**, 61–71 (1928); *cf.*, *C. A.*, **21**, 3853.—The As is obtained in the trichloride form, is then mixed with a cocaine molybdic reagent and is determined nephelometrically against an As standard. With this method it is possible to determine As in amounts as low as 0.0005 mg. The error is 2–3% above 0.005 mg. and 5% below this amount. All solutions to be tested for As by this method must be free from PO_4. (*C. A.*)

Volumetric determination of barium as chromate. A. MAZZUCCHELLI AND B. ROMANI. *Gazz. chim. ital.*, **57**, 900–13 (1927).—The Le Guyon method for the determination of Ba (*C. A.*, **21**, 1778) and the ionic equilibria necessary for the successive precipitation of $BaCrO_4$ and Ag_2CrO_4 were examined critically. Experiments in which varying proportions (including a deficiency) of K_2CrO_4 were added to mixtures of $Ba(NO_3)_2$ and $AgNO_3$ show that Ag_2CrO_4 is carried down with $BaCrO_4$ as a solid solution or is superficially adsorbed, and that as a result of this it is almost impossible to determine Ba volumetrically with $AgNO_3$ in a reliable manner. Attempts to avoid this entrainment of Ag_2CrO_4 by simultaneous precipitation of $BaSO_4$ were unsuccessful. Determinations of the equilibrium between the mixed precipitate and the solution of its cations showed that under ordinary condition solid solutions are formed to only a limited extent. A theoretical discussion of the potentiometric titration of the Ag ion as Ag_2CrO_4 such a titration does not give precise results, but the method can be improved by using dilute alcohol (about 45% EtOH) solutions, in which case the method gives promising results as a practical method for the indirect titration of Ba. (*C. A.*)

Analytical filtration accelerated. ANON. *Laboratory*, **1**, 4–7 (1928).—The Fischer Scientific Co. of Pittsburgh, Pa., is now placing on the market "accelerators" which disintegrate into filter paper pulp when stirred into a solution. The pulp acts as a mechanical suspensoid and particles of finely divided precipitate adhere to it so that they do not clog the filter. Thus a $BaSO_4$ precipitate can be filtered in about half the usual time when an accelerator has been added. (*C. A.*)

Analysis of the sodium sulphate used in glass works. Direct determination of sodium sulphate. A. BESOMBE. *Bull. soc. chim. Belg.* **37**, 164–5 (1928).—Commercial Na_2SO_4 usually contains free acid, NaCl, and Fe, Al, Ca and Mg sulphates as impurities. In order to titrate Na_2SO_4 directly add a little excess of Na_2CO_3 of known concentration the free acid is thus neutralized, whereas the heavy metals precipitate; filter; neutralize the excess of Na_2CO_3 with H_2SO_4; evaporate and calcine in a weighed crucible; subtract the weight of NaCl and of the Na_2SO_4 formed by the neutralization of the carbonate. Titrate the free acid and NaCl separately. (*C. A.*)

The symmetry of orthoclase. TOM BARTH. *Norsk. Geol. Tids.*, **9**, 398–400 (1927).—As shown by A. Hadding (*Lunds Universitets Årsskrift*, **2**, No. 6 (1921)) the ordinary cross-hatched microcline gives Laue diagrams completely similar to those of orthoclase. When using a simple microcline consisting of a single crystal individual and thus without the common cross-hatching on (001), a somewhat different Laue diagram is obtained. B. presents and discusses such a diagram and concludes: Since all the spacings of microcline, as accurately as they can be determined on an ordinary Laue photograph, are

equal to the corresponding spacings of orthoclase, these 2 minerals cannot be different modifications of K feldspar. As the orthoclase gives a Laue photograph identical with that of a cross-hatched microcline the former must consist of submicroscopically twinned lamellas of the latter. (*C. A.*)

Decomposition of clays. L. WASILEWSKI. *Przemysl Chem.*, **12,** 40–48 (1928).—The decomposition of clays and kaolins by means of $(NH_4)_2SO_4$ and the individual factors involved were studied. The decomposition proceeds as if first $(NH_4)HSO_4$ and ammonium alum were produced, which reaction would go up to 357°, and next NH_3 and $(NH_4)_2SO_4$ were driven off from the alum, which reaction would begin at 420–30° and end above 450°. The temperature of decomposition affects the losses of NH_3 since up to 360° about 0.5% NH_3 used in the reaction is oxidized and ammonium alum is leached out of the products, while at 450° about 9% NH_3 is oxidized and at the same time $Al_2(SO_4)_3$ is obtained. A curve showing the relationship between the temperature and per cent NH_3 oxidized is given. Clays of varying chemical composition decompose at different times and in different ways, *e.g.*, clays with a higher Fe_2O_3 content release NH_3 more easily and quickly than those of lower Fe_2O_3 content, and those free from Fe_2O_3 resist conversion to $Al_2(SO_4)_3$. (*C. A.*)

Quantitative separation of arsenic, antimony, and tin. A. THÜRNER. *Z. anal. Chem.*, **73,** 196–200 (1928).—Given a solution of the thio salts of As, Sb, and Sn, such as is obtained by fusion with Na_2CO_3 and S, it is easy to carry out a separation which is sufficiently accurate for technical purposes. First of all, make the solution neutral to litmus and add a few drops of NaOH solution. Oxidize by adding perhydrol and heating. Add 10 g. of NH_4Cl, heat 1 hour, cool to 30°, add 1–2 cc. of HCl and saturate with H_2S for 30–40 minutes. Filter and wash with water containing NH_4Cl; hereby As is left in solution as soluble thio salt while SnS_2 and Sb_2S_5 are precipitated. To the filtrate, add 5 g. of Na_2CO_3, oxidize the sulphide with perhydrol, and precipitate the As as $MgNH_4AsO_4$. Treat the sulphide precipitate with 40 cc. of concentrated HCl, dilute with an equal volume of water and then carefully dilute to 300 cc. Add 10–12 cc. of concentrated HCl and exactly 16–17 g. of NH_4Cl. Precipitate Sb with H_2S, filter, heat in CO_2, and weigh as Sb_2S_3. Boil off H_2S from the last filtrate, neutralize with NH_4OH, and precipitate hydrated SnO_2 by boiling with NH_4NO_3. (*C. A.*)

Reaction in the solid state at high temperatures. I. Rate of reaction for an endothermic change. WILHELM JANDER. *Z. anorg. allgem. Chem.*, **163,** 1–30 (1927).—An endothermic and an exothermic reaction can be differentiated by plotting a rate of reaction curve and noting its shape. The theory for the reaction between 2 kinds of crystals is presented. The rate of reaction is dependent on temperature and size of crystals. A description of apparatus used for experiments is given. The rate of reaction is measured for $BaCO_3$ and $CaCO_3$ with SiO_2 and for $CaCO_3$ with Mo oxide. The effects of temperature and of grain size were studied. Excellent agreement is found between experimental data and theoretical calculations. **II. Reaction velocities of exothermic reactions.** *Ibid.*, **166,** 31–52 (1927).—Reactions in the solid state depend upon general diffusion laws. Equations for the dependence of a reaction on time, particle size of the powdered components and temperature may be deduced. The dependence of reaction velocity on temperature is expressed theoretically by the equation $k' = C'e^{-a/T}$. T is the absolute temperature. C' and a are constants. Endothermic reactions have been shown to obey this relation. Exothermic reactions require a somewhat different treatment because the heat evolved in the reaction produces local rises in temperature of the reacting parts of the mixture. Toward the end of a reaction, however, when the reaction velocity is so small that the heat of reaction is conducted uniformly throughout the reaction mixture, the equation given above should apply strictly. In the reactions $BaCO_3+WC_3 \rightarrow BaWO_4+CO_2$ (two different reaction

mixtures, 1 mol. $BaCO_3$ to 10 mols. WO_3 and an equimolar mixture) and $Ag_2SO_4 + PbO \rightarrow Ag_2O + PbSO_4$, the velocity of the end reaction is found to vary with temperature according to the equation given. From the difference between the velocities of the beginning and end reactions it is possible to determine the effective local temperature rise in the reacting parts of the mixture, this rise being as much as 100° if the external temperature is high. The theoretical equation for dependence of the reaction on time and particle size, when the effect of the heat of reaction is allowed for, also represents the experimental data satisfactorily. (*C. A.*)

The binary system: Mn_2SiO_4–Ca_2SiO_4. L. TOKODY. *Z. anorg. allgem. Chem.*, **169,** 51–56 (1928).—The conclusion of Kallenberg (cf. *C. A.*, **8,** 3281) that the components of this system form an isodimorphous series and that the melting-point curve is of the Bakhuis-Roozeboom type III has been confirmed. SiO_2, $CaCO_3$, and Na_2CO_3 were well mixed in a mortar, formed into cylinders and sintered at 800–1000° in an atmosphere of N in a resistance furnace. The sintered mass was first pulverized then and melted in a graphite crucible in an atmosphere of N. Crystals formed during a period of 1–1.5 hrs. at a practically constant temperature. The melting points were determined on thin sections on Pt foil on the stage of a microscope; for high Ca content an optical pyrometer was used. A continuous melting-point composition curve is obtained with a minimum (1160°) at 90 mol. % Mn_2SiO_4 and 10 mol. % Ca_2SiO_4. The mixed crystals are rhombic Mn_2SiO_4 with γ Ca_2SiO_4. They have a prismatic habit and cleavage, belong to the rhombic system, are biaxial, show parallel extinction and are optically negative. For pure artificial Mn_2SiO_4 density = 4.05; 50 mol. % mixed crystal density = 3.39; pure Ca_2SiO_4 exists in 3 forms: α density = 3.27, melting-point 2080°; β density = 3.28 (approximate), stable 675–1410°; γ density = 2.97, stable at low temperatures. The α and β forms change to γ spontaneously on cooling. (*C. A.*)

BOOKS

Optic and Microscopic Characters of Artificial Minerals. A. N. WINCHELL. Univ. of Wis. *Studies in Sci.*, No. 4. 215 pages. University of Wisconsin, Madison, 1927. Price, $1.50. Reviewed in *Ind. Eng. Chem.*, **20** [5], 554 (1928). For review see *Ceram. Abs.*, **7** [5], 324 (1928). R.J.P.

The Condensed Chemical Dictionary. New York: The Chemical Catalog Co., Inc. 528 pp. Flexible binding (thumb index.) $7. (*C. A.*)

A First Book in Chemistry. ROBERT HART BRADBURY. Revised ed. New York: D. Appleton and Co. 674 pp. (*C. A.*)

Quantitative Chemical Analysis. CHARLES M. ALLEN. 2nd ed. New York: John Wiley and Sons. 86 pp. $1.50 net. Reviewed in *Jour. Chem. Education*, **5,** 371 (1928). (*C. A.*)

General

Trends in manufacturing management. CHARLES W. LYTLE. *Bull. Amer. Ceram. Soc.*, **7** [7], 174–84 (1928).—Trends in manufacturing are traced from the first industrial revolution, when machinery was first introduced, through the various principles which are now commonly followed. Besides the coördinating function of higher administration, twelve major "mechanisms of management" in use in the most successful plants are: budgetary control, market analysis, quality control, stores control, maintenance of plant and equipment, process and operation analysis (job standardization), planning and scheduling, production control, incentives, labor control, standard costs, research, and design. E.J.V.

Operating conditions in waste heat driers. R. K. HURSH AND R. G. MILLS. *Brick Clay Rec.*, **73** [1], 26–30 (1928).—Valuable information about drying is given in this report of an investigation of waste heat driers. The study was undertaken to determine

the conditions of temperature, moisture, loss of the ware, and other factors which were of interest and affected by the operation of brick driers under plant conditions. Tests have been made at each of three different plants with driers of somewhat different type and construction and with somewhat varying methods of operation. Data has been accumulated in order to study the drying procedure over a considerable period of time with the fluctuating conditions that enter in plant practice. Time has not permitted a full and complete analysis of all the data obtained but valuable information has been acquired and definite results have developed. E.J.V.

Canadian Clay Products Association's 26th meeting. ANON. *Brick Clay Rec.*, **73** [1], 31–33 (1928).—A report of the convention held at Montreal, June 13, 14, and 15. Papers presented include: "The Technical Development of Ceramics in Eastern Canada," by R. J. Montgomery; "Pyrometry," by F. J. Leduc; "Application of Continuous Kiln Principles to Downdraft Kiln Burning," by D. D. Omundsun; "Economy in Shale Blasting," by F. T. Hallford; "Chemistry in the Clay Products Laboratory," by W. E. Patterson, and several others. E.J.V.

Better merchandising. ANON. *Clay-Worker*, **89** [6], 459–61 (1928).—Realizing that there is a real need in the clay products industry for better merchandising practice, some pertinent suggestions for the building up thereof are presented. E.J.V.

Better merchandizing in Evansville. HENRY C. KLEYMEYER. *Clay-Worker*, **89** [6], 462 (1928).—The Standard Brick Mfg. Co., of Evansville, Ind., is operating 3 different kinds of clayworking plants and marketing the product in 19 states. The growth in sales has been due to building as wide an acquaintance as possible, and joining all business, civic, and social organizations in Evansville, as well as practically all organizations in the clay products industry. Constant research in improving plant equipment and products has been accompanied by development of selling stunts and enterprising sales effort. E.J.V.

Better merchandising in Detroit. CHARLES A. BOWEN. *Clay-Worker*, **89** [6], 463–64 (1928).—It was found that though fired clay products were accepted and acknowledged to be a superior article for building construction work, the sales were dropping off until the manufacturers began to make it an important part of their business to advertise and merchandise their product. As a result of intensive effort along these lines common brick are coming back into its proper place of prominence in the building material field after having been sidetracked by inferior materials. E.J.V.

Coöperative effort the big thing. W. E. DUNWOODY. *Clay-Worker*, **89** [6], 468–71 (1928).—A discussion of how fired clay products manufacturers in the South are working out their mutual problems in merchandising, etc., through a consistent educational campaign and increased advertising activity. E.J.V.

Better merchandising of common brick. RALPH P. STODDARD. *Clay-Worker*, **89** [6], 476–77 (1928).—An account of how the Common Brick Manufacturers' Association has been developing merchandising service for the manufacturer. This has consisted of a variety of literature covering the various uses of brick and an architectural plan service which is believed to be second to none in the building material field as applied to small houses, and in newspaper advertising copy supplementing the national advertising campaign. A booklet has been prepared for the brick salesman, which interprets in language easily understood all of the technical data resulting from the Association tests of brickwork, together with many practical helps for the salesman. A special course in common brick merchandising is also being prepared by specialists in building merchandising aids. E.J.V.

New Jersey Clay Workers Association summer meeting. ANON. *Clay-Worker*, **89** [7], 556 (1928).—A report of the meeting held June 8, 1928 at Asbury Park. Papers read include a report of the committee on kiln data, given by D. P. Forst, "Plant Co-

operation," by Maurice A. Chaffee, and "Simplified Practice as Applied to the Ceramic Industry," by P. H. H. Dunn. E.J.V.

Clay Products Institute of California. ANON. *Clay-Worker*, **89** [7], 570 (1928).—An announcement of the formation of the Institute, which includes in its membership the manufacturers of face brick, terra cotta, hollow tile, roofing tile, sidewalk and paving brick, sewer pipe, segment blocks, vitrified clay sewer pipe liners, drain tile, flue lining, chimney pipe, patent chimneys, common brick, sewer brick, and selected common brick. The purposes of the Institute will be to foster the proper use of clay products and to this end public tests of building materials will be advocated so that better construction will result, and the right material used in the right place. Technical data will be prepared and experts will be available to take up different problems. E.J.V.

New feldspar mill at Trenton. ANON. *Glass Ind.*, **9** [7], 160 (1928).—The new feldspar grinding mill of Golding Sons Co. and Erwin Feldspar Co., at Trenton, N. J., was put in operation in June. Novel features are embodied in its design and construction. A brief account of the plant and process is given. Golding Sons Co.'s new mill at Spruce Pine, N. C., has also been completed, having a capacity of approximately 100 T. a day. This is designed a little differently from the one at Trenton and has a slightly different flow sheet. E.J.V.

Glass technologists tour Germany. II. ANON. *Pottery Gaz.*, **53** [613], 1097–1110 (1928).—In Weisswasser the plants visited included the older works of Osram Co., where hand labor still survives and the older type equipment is still in use, the Vereinigte Lausitzer Glaswerke, a factory producing a big range of table and ornamental glassware, and the Osram tube factory, a very clean, systematically arranged works, wherein fully continuous Danner tube-drawing machines were seen in operation producing hollow tubing and solid rod. At Brockwitz, a glassworks known as the Aktien-Gesellschaft Brockwitz, an important concern employing many hundreds of hands and manufacturing a big range of inexpensive commodities in pressed table glass, was inspected. At Karlsruhe a visit was paid to a world-renowned technical high school which has a section devoted to scientific experiments in connection with glass, glazing enamels, and pottery. E. Zschimmer is in charge of this department. In the village of St. Ingbert, the window glass factory of Vopelius and Wentzel, one of the first window glass factories in Germany to have been equipped with machines of the Foucault type, was visited. Privilege was granted to visit the Ruhr Glassworks. This factory is divided into two sections, one of which is engaged in the production of bottles and the other in the manufacture of drawn tubing and rod. Several other towns of general interest were visited and warm welcomes were received in all places. For part I see *Ceram. Abs.*, **7** [7], 533 (1928). E.J.V.

Russian pottery and glass industry. ANON. *Pottery Gaz.*, **53** [613], 1130 (1928).—On the first quarter of the current economic year the cost of production in the factories of the Central Porcelain Trust shows a decline, compared with the preceding year, of 6%, which is still 3% less than the program reduction, *i.e.*, 3% too high. In the second quarter, however, the reduction in production cost amounted to 14.5%. This sharp improvement is due, as in some of the chemical works of the country, to a better use of the raw material, prices for which in some cases are down; but the chief cause is the better proportioning of the raw material. Following on closer laboratory work, cheaper clay of good quality has been introduced. Fuel economy has also been effected. The new furnaces are on the Groum-Grjimailo system. Power plants have also been much improved. The production per labor unit is better by 19%, and wages are up 3%. The lower cost of production has been accompanied by a profit of 301,000 rubles this half-year compared with the loss of 713,000 rubles in the first half of last year. The Presidium of the Supreme Economic Council has approved the plant for the concentration of the glass industry in the R.S.F.S.R. Four trusts are to be formed, two of

republic-wide and two of local importance (in the Urals and North Caucasus). The first State's trust will control 25 factories with a yearly production valued at 48,000,000 rubles and a staff of 12,000 workers while the second will control 30 factories with 14,000 workers and a production of 47,000,000 rubles. E.J.V.

"Ceramic Week" at Paris. ANON. *Pottery Gaz.*, **53** [613], 1131 (1928).—At the sixth technical congress of the French ceramic industry, which began on May 29, papers read included communications on the question of calorifuges and their use in the ceramic industries, by M. Damour, and on the use of ball-bearings in the ceramic industries. Victor Bodin read a paper on ceramic furnaces, Marc Larcheveque discussed casting and its applications, M. Roszack spoke on the evolution of boilers during the last ten years, and explained the influence of this evolution on the quality of refractory products used, and also dealt with the use of refractory materials in furnaces heated with pulverized coal. J. B. Monnier read a paper, supported by numerous data, on the choice of raw materials in the manufacture of paving brick, and the quality required in such brick compared with the other products of the ceramic industry. A banquet was given in honor of members of the AMERICAN CERAMIC SOCIETY who were present. E.J.V.

Plant coöperation and simplified practice discussed. ANON. *Ceram. Age*, **11** [6], 205–11 (1928).—The following papers were presented at the summer meeting of the New Jersey Clay Workers' Assn., (1) "Plant Coöperation," by M. A. Chaffee, (2) "Simplified Practice as Applied in the Ceramic Industry," by P. H. H. Dunn. A.E.R.W.

Simplified practice as applied to the ceramic industry. P. H. H. DUNN. *Ceram. Age*, **11** [6], 211–13 (1928).—D. states that the opportunity for corrective action grows steadily in the increase of understanding of what waste actually is. Labor that is unemployed is waste. Slow or interrupted transportation is waste. Seasonal operations and idle machinery mean waste. Competition is increasing. D. outlines the work of the Hoover committee, showing that simplified practice means the elimination of of over-diversification. When undertaken by an entire industry, the consumer secures the maximum of benefit. D. outlines the work that has been accomplished in other fields giving a table showing the accomplishments in the construction industry. The reduction of 66 sizes of paving brick to 5 is discussed. A table of recommendations for ceramic ware is given. An editorial note which is appended gives a brief report of the conference which resulted in the adoption of a commercial standard for all-clay plumbing fixtures. A.E.R.W.

Economics of industrial fuels. E. G. DECORIOLIS. *Ceram. Age*, **11** [6], 222–24 (1928).—For many industries, fuel is the determining factor in locating the plant, but in ceramics other raw materials come first. C. gives a table showing the characteristics of the important fuels. The following fuels are then discusssed in detail and their advantages and disadvantages listed: bituminous coal, wood, oil, gas, and electricity. A.E.R.W.

Embrittlement of boiler plate. S. W. PARR AND F. G. STRAUB. Univ. of Ill. Eng. Expt. Sta., *Bull.*, No. 177, 67 pp. (1928).—Data has been obtained since the publication of *Bull.*, No. 155 on the embrittlement of boiler plate. For the boiler failures investigated no fault was found in the design, workmanship, or material of the boiler; an alkaline condition of the feed water with a low sulphate content was found in all cases; sodium hydroxide was the only material present which has been shown to have an embrittling effect on steel; and increasing the sulphate content inhibited embrittlement. Several other embrittlement inhibiting agents were developed and are described. A.E.R.W.

Trend of power-plant design. F. H. DANIELS. *Blast Fur. Steel Plant*, **16** [6], 790–93 (1928). F.P.H.

Daily plant log for efficient production control. E. H. VAN SCHOICK. *Brick Clay Rec.*, **72** [13], 908–10 (1928); *Ceram. Ind.*, **11** [1], 62–64 (1928).—A daily plant log of all manufacturing conditions which might affect the quality of the product is recommended for efficient plant production. F.P.H.

Lignin extract makes cheap organic binder. ROBERT M. KING. *Ceram. Ind.*, **11** [1], 43–45 (1928).—Frequently a need arises for a cheap organic binder for increasing the dry strength of ware. For many years lignin extract has been used to increase the strength of foundry cores. Isolated experiments have shown that it holds considerable promise for the ceramic industries. The dry strength of bodies can be increased 100% by the use of .5% lignin extract. F.P.H.

Natural and artificial drying. VON P. THOR. *Tonind. Ztg.*, **52** [19], 342–44 (1928). —Natural and artificial drying are compared. F.P.H.

World trade in products of the fine ceramics industry in 1927. KURT LUDWIG. *Keram. Rund.*, **36**, 192–96, 211–14 (1928).—In 1927 Great Britain, Germany, France, and Czechoslovakia furnished 70% of the total value of the world's exports in fine ceramic products. The total value of the world trade in fine ceramic products in 1927 increased 85% over that in 1918. While before the war Germany led the world in the export of fine ceramics England now has first place. Germany's decrease in exports in 1927 is ascribed to the raising of England's import tariff on this type of goods. Detailed tables showing Germany's exports with the amount to each destination are given. H.I.

Polish tariff vs. German imports. ANON. *Keram. Rund.*, **36**, 277–78 (1928).—Lists showing the increases in import duties into Poland of various articles of German fine ceramics due to the stabilization of the Polish zloty on Feb. 14, 1928 are given. H.I.

Effect of Saar agreement on the ceramic and glass industries. ANON. *Keram. Rund.*, **36**, 295–97 (1928).—The tariff treaty of Feb., 1928, between Germany and France with reference to the Saar region is described. H.I.

American chemical industries. P. C. KINGSBURY. *Ind. Eng. Chem.*, **20** [5], 550–52 (1928).—A review of the establishing and growth of the General Ceramics Co. R.J.P.

Buying china and glass in Europe. F. CALVIN DEMAREST. *Crockery and Glass Jour.*, **106** [10], 43–44 (1928).—Some of the advantages of buying in Europe are that buyer is enabled to make his purchase direct from the foreign manufacturer, he gains prestige for his store, etc. Disadvantages are: he takes the chance of a late delivery, the possibility of receiving poorer grade material than he ordered, and a delay in getting the matter adjusted. E.P.R.

Cement industry joins in the demand for a protective tariff. GEORGE GARNER. *Mfgr's. Rec.*, **92**, 55–56 (1928).—Resolutions presented and adopted at the spring meeting of the Portland Cement Assn. in New York and difficulties encountered in competing with foreign cements are discussed. E.P.R.

Steam storage. ANON. *Mech. World*, **83** [2153], 257 (1928).—A method of steam accumulation in large volumes and of great importance to many different industries devised by Johannes Ruths of Stockholm is described. E.P.R.

Combustion of coal as applied to steam generation. F. H. ROSENCRANTS. *Mech. World*, **83** [2153], 257–59 (1928).—Prominence has been given to the application of pulverized fuel for firing of boiler furnaces. Authentic gross efficiencies of 87 to 89% are being obtained in several instances. *Ibid.*, [2154], 276–78 (1928).—Discusses the advantages and disadvantages of horizontal and vertical types of driers and finds many disadvantages in both. One form of solution to overcome the limitations of the above is the development of steam-heated driers with gravity flow, supplemented with

positive propelling equipment for ensuring uniform flow of coal. Drying by means of admission of hot air from the air preheater, or flue gas from the boiler outlet, into the pulverizer is also described with a diagram and set of figures. Pulverizers are discussed. *Ibid.*, [2155], 295–97 (1928).—Feeders for pulverized coal are discussed. Three factors effecting rapidity of combustion of pulverized coal are elaborated. Types of burners are discussed and difficulties related. *Ibid.*, [2157], 330 (1928).—The appeal of the direct-fired system of pulverized fuel is based on simplicity and low first cost. It consists of a pulverizer placed in front of the boiler under the raw-coal bunker and is more often found associated with cheap installations than is the bin-and-feeder system. The pulverizer is the only element between the raw-coal bunker and the burner. It is of the high speed beater type and no crushing between metal surfaces takes place. *Ibid.*, [2159], 366 (1928).—Traveling-grate stokers and stoker furnaces are discussed and solutions are offered for the more common problems encountered in the use of various stokers. E.P.R.

Works management and organization. ANON. *Mech. World*, **83** [2153], 259–260 (1928).—Two conditions are considered, (1) a new factory and, (2) an existing factory to be converted or reorganized. There are two alternative schemes for the arrangement of machines, (*a*) to allocate all machines of one type to a particular shop, and (*b*) to subdivide the work into assemblies and shops, and equip each shop with requisite machines to enable it to carry out all work on the articles with which it deals. Production organization is based on the accuracy of preliminary estimating. The supply of raw material should be synchronized with the demand for the finished article. E.P.R.

Works management and organization. ANON. *Mech. World*, **83** [2154], 272–74 (1928).—The production department is divided into two sections: (1) Financial division is responsible for preparing labor estimates, planning all machine operations in detail, and fixing piece prices. Before new or special tools are ordered the following formula is used to determine whether or not a change is justified, $N = \frac{19\ T}{20\ (E-S)}$, where E = cost of using existing tools; S = cost of using special tools; T = cost of special tools; N = number of parts to be made. This formula allows for the plant or metal value of tools as 5% of the original cost. (2) Materials division controls supplies of materials, supervises its progress and arranges that work is completed as required. A suitable "slide rule" is described as an assistance in preparing the program. E.P.R.

Surveying a foreign market. ANON. *Mech. World*, **83** [2155], 286–87 (1928).—The various methods by which a foreign market should be surveyed are discussed. Consultation with the surveys issued by the Department of Overseas Trade or that issued by the U. S. Department of Commerce is emphasized. E.P.R.

Electric power in workshop and factories. E. B. P. *Mech. World*, **83** [2156], 304 (1928).—The application of electric drive to engineering works is discussed with examples. E.P.R.

Works management and organization. ANON. *Mech. World*, **83** [2156], 309 (1928).—The materials section is responsible for all delivery dates both outside and inside the firm. All material is put into the shops on a requisition consisting of three copies (*a*) requisition to stores, (*b*) delivery note, (*c*) copy of requisition. The work accountant controls the clerks for computing wages, etc., pricing, posting, costs, etc. Weekly a summary of money spent on material and labor is prepared to compare with progress records. Systems of inspection are varied, some plants use a separate inspecting department, others have each charge-hand act as examiner to his own gang and he has a particular and characteristic stamp so that faulty work is easily traced. E.P.R.

Mounting driving belts. ANON. *Mech. World*, **83** [2156], 313–14 (1928).—No single safeguard has been found to deal with every case, but a large proportion of accidents could be prevented by using such safeguards as are available. Portable belt mounters include, (*a*) simple straight belt poles and belt sticks, (*b*) poles fitted with curved, flexible or jointed ends, designed for positions where straight poles are impossible. To minimize belt breaking the following should be guarded against: (1) fixing metallic fasteners in wrong position; (2) cutting the butt ends of the belt otherwise than at right angles to the line of the belt, so producing an uneven strain in use; (3) using fasteners too small or too light; (4) making holes for fasteners unnecessarily big thus weakening the cross-section of the belt. E.P.R.

Reducing the fire hazard. H.T.U.R. *Mech. World*, **83** [2158], 340–41 (1928).—The causes and preventatives of fire hazards in manufacturing plants are discussed in detail. E.P.R.

Spray ponds for cooling water. ANON. *Mech. World*, **83** [2158], 345–46 (1928).—The advantages and economics of spray ponds are compared with cooling towers. E.P.R.

Blast furnace automatic feeding installation. ANON. *Mech. World*, **83** [2158], 346–47 (1928).—The first blast furnace in England to be equipped with completely automatic charging has recently been put into operation by Guest, Kenn, & Mellefold, Ltd. at East Moors, Cardiff, and has proved a marked success, the weekly output of the furnace having achieved the record of 3600 tons. A detailed description is given. E.P.R.

Automatic feed-water regulation. WALTER SMITH. *Mech. World*, **83** [2160], 375–76 (1928).—Automatic devices for feeding water to boilers are discussed with detailed descriptions of (1) those which control the admission of the feed-water by a periodical opening and closing of the check-valve, and which maintain a constant level in the boiler, (2) those which control by throttling the feed supply, and consequently give a continuous feed in proportion to the evaporation and which vary the boiler level according to the load. E.P.R.

High speed Diesel engines. O. D. TREIBER. *Mech. World*, **83** [2160], 381–82 (1928).—The evolution and development of the Diesel engine is discussed in detail. The present demand is for a high speed engine of light weight. High revolutions are limited by the weight of reciprocating parts and the reduction of weight is limited by (1) selection of material, (2) design to eliminate unnecessary weight within allowable stresses of these parts. In the selection of materials for reciprocating parts the aluminum alloy for pistons is important saving 60% over ferrous metal pistons. A general description of the engine with diagrams is given, together with a short discussion of its economic uses. E.P.R.

Rules for the maintenance of motor insulation. ANON. *Refrac. Jour.*, **3** [28], 688 (1928).—(1) When oiling or greasing bearings, be sure excess lubricant does not get into windings; (2) when motors are in transit, in storage or idle for an extensive period, protect them against moisture and dust; (3) if a motor has become damp, dry it out before operating it; (4) after drying a motor, test it for insulation resistance, and then subject it to the high-potential test; (5) maintain a system of periodic inspection of all motors (weekly inspection and partial cleaning is recommended for motors in average service); (6) give every motor a thorough cleaning once a year, or oftener if the conditions warrant; (7) if any inflammable cleaning liquid is used, guard against the accumulation of explosive vapors in pits and basements. E.P.R.

The history of ceramics. C. F. BONINI. *Giorn. bibl. tech. intern.*, **3**, 763–74 (1927). (*C. A.*)

Research laboratory (American Steel Foundries). W. C. HAMILTON. *Trans. Am. Foundrymen's Assn.*, (reprint), No. 28, pp. 105–18 (1928). (*C. A.*)

Book Review

The Clay Resources and the Ceramic Industry of California. WALDEMAR FENN DIETRICH. Published by State of California, Dept. of Natural Resources, Fred G. Stevenot, director, San Francisco, *Bull.*, No. 99, Jan., 1928.—This report deals in detail with the growing ceramic industries of California with special emphasis on the raw materials available. Reports of tests on clays and minerals were carefully done and the data well reported. The geology and geography of the ceramic resources, and a description of the principle plant are given in detail. The report is well indexed.

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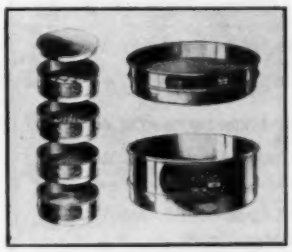

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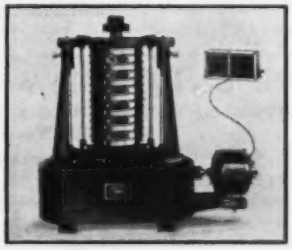

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Department of Ceramic Engineering COLUMBUS, OHIO

Founded 1895

Curriculum—Ceramic engineering and technology. Advanced research in cooperation with State owned plants and Federal Government.

SIX INSTRUCTORS *Head of Department:* ARTHUR S. WATTS

NEW YORK STATE SCHOOL OF CLAY-WORKING AND CERAMICS

ALFRED UNIVERSITY, ALFRED, NEW YORK

Founded 1900

Curriculum—Ceramic Engineering, Ceramic Chemistry, Applied Art

SEVEN INSTRUCTORS *Director:* CHARLES F. BINNS

RUTGERS UNIVERSITY

NEW BRUNSWICK, N. J.

Ceramic Department founded 1902

Curriculum—Ceramic Technology and Engineering

THREE INSTRUCTORS *Director:* GEORGE H. BROWN

UNIVERSITY OF ILLINOIS

Department of Ceramic Engineering URBANA, ILLINOIS

Founded 1905

Curriculum—Ceramic Engineering and Ceramics, the latter is a non-engineering course in the technology of ceramic products.

SIX INSTRUCTORS and a research associate *Head of Department:* C. W. PARMELEE

IOWA STATE COLLEGE

Department of Ceramic Engineering, AMES, IOWA

Founded 1906

Curriculum—Ceramic Engineering major, Ceramic Technology and Pottery subordinate.

THREE INSTRUCTORS *Head of Department:* PAUL E. COX

THE UNIVERSITY OF NORTH DAKOTA

Department of Ceramics and Ceramic Engineering, GRAND FORKS, N. D.

Founded 1910

Curriculum—Ceramic Art and Technology

FIVE INSTRUCTORS *Director:* A. W. GAUGER

UNIVERSITY OF WASHINGTON

Department of Ceramic Engineering SEATTLE, WASHINGTON

Founded 1918

Curriculum—General ceramic engineering with research in ceramics and non-metallics.

Coöperation with the U. S. Bureau of Mines

Director: HEWITT WILSON *Assistant:* J. H. YATES

UNIVERSITY OF SASKATCHEWAN

SASKATOON, SASK.

Founded 1921

Curriculum—Ceramic Engineering

TWO INSTRUCTORS *Head of Department:* W. G. WORCESTER

PENNSYLVANIA STATE COLLEGE

Department of Ceramics, School of Mines and Metallurgy

STATE COLLEGE, PENNA.

Founded 1923

Curriculum—Ceramic Engineering

Head of Department: J. B. SHAW *Instructor:* GEO. J. BAIR

GEORGIA SCHOOL OF TECHNOLOGY

ATLANTA, GEORGIA

CERAMIC DEPARTMENT

Founded 1923

Curriculum—Ceramic Technology and Engineering

TWO INSTRUCTORS *Director:* A. V. HENRY

NORTH CAROLINA STATE COLLEGE OF AGRICULTURE & ENGINEERING

RALEIGH, NORTH CAROLINA

Department of Ceramic Engineering founded 1923

Curriculum—Ceramic Engineering

TWO INSTRUCTORS *Head of Department:* A. F. GREAVES-WALKER

WEST VIRGINIA UNIVERSITY

MORGANTOWN, W. VA.

Ceramic option course founded 1924

Curriculum—students selection of ceramics includes chemical and engineering principles applied to ceramic manufacture.

TWO INSTRUCTORS AND TWO ASSISTANTS *Director:* W. A. KOEHLER

UNIVERSITY OF TORONTO

TORONTO, CANADA

Founded: University, 1827. Department of Metallurgy, Ceramic Division, 1925.

Curriculum—Ceramic Engineering and Technology

TWO INSTRUCTORS *Principal Instructor:* ROBERT J. MONTGOMERY

MISSOURI SCHOOL OF MINES & METALLURGY

OF THE UNIVERSITY OF MISSOURI, ROLLA, MO.

Founded 1926

Curriculum—Ceramic Technology and Ceramic Engineering

TWO INSTRUCTORS

Director: CHAS. H. FULTON *Head of Department:* M. E. HOLMES

LOUISIANA STATE UNIVERSITY

BATON ROUGE, LA.

Ceramic Department founded 1926

Curriculum—Ceramic Engineering

Head of Department: J. W. WHITTEMORE

THE OHIO STATE UNIVERSITY

Department of Fine Arts COLUMBUS, OHIO

Founded 1927

Curriculum—ceramic art and technology to train artists for the ceramic industries.

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BULLETIN
of the
AMERICAN CERAMIC SOCIETY

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific, and Art Questions and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

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Vol. 7 | September, 1928 | No. 9

EDITORIALS

WHAT IS BEING DONE IN CERAMIC ARCHITECTURE IN EUROPE[1]

BY H. O. WARNER

Introduction

The increasing use of ceramics in modern architecture in Europe is particularly noticeable to the discerning eye of the professional traveler. A trip through the northern countries of the Old World, especially Sweden, Denmark, Holland, and the greater part of Germany is a revelation to the American student and craftsman, and can be an all-powerful influence in stirring the creative imagination necessary to make a living and forceful art of our own times.

That the modern movement in architecture would stimulate all the allied arts into new created energy was but to be expected and that the ceramic industry would be among the first to feel and stimulate this movement should be a foregone conclusion.

Modern Architecture

The appeal of modern architecture to the creative mind by development of a mass form, heretofore not generally used has forced the

[1] Presented at the Annual Meeting, AMERICAN CERAMIC SOCIETY, Atlantic City, N. J., February, 1928. (Art Division.)

architect into a more comprehensive study of the economic use of building materials having beauty of color and texture. It is in such a medium that the more general use of tile, terra cotta, and molded brick of engaging texture have become of great service to the European architect. In America, the architectural profession has been content, when not building in stone or brick, to use either the white or buff glazed terra cotta offered by the leading manufacturers. The American architect is slow to be intrigued by the attempt of a few manufacturers to sympathetic work in color. In Europe the architects work in unison with the ceramic industry, both being alive to the opportunity of using the architectural tile and brick glazed in the most striking colors giving the designer an entire color scale to work with. One of the most beautiful interiors to be seen in Europe is the great hall of the Planetarium in Düsseldorf, Germany, where the architectural form of the great vaulted hall, walls, ceiling, and floor are clothed in glazed tile of harmonious and varying shades of green. An excellent example of the sympathetic understanding between the architect and the craftsman.

To the worker in mosaics the great golden banquet hall in the new city hall at Stockholm is a revelation. This building, one of the most beautiful and satisfying of modern times offers many surprises to the more imaginative worker in ceramics and alone is well worth a trip to Europe.

For the student of the texture, form, and color of brickwork the modern architecture of the larger cities of Holland will reveal much that is undreamed of here. The surprising originality of their use of brick forms again clearly indicates a working understanding between the architect and the craftsman. All throughout the older cities an extremely interesting and virile architecture is being produced with the forms placed in the hands of the profession by the craftsworker. The supply is as keenly imaginative in quality as the modern would wish, with the result that he is not always groping for materials to carry out the ideas formulating in his fertile brain but instead is stimulated to greater imagination by what is offered him at every hand.

In Germany where a particularly fervent imagination is at work an inherent attention to the practicability of the form being created is very noticeable. It is for this reason that the architectural profession has been quick to take advantage of the varied forms and shapes produced in building tile doubly valuable for their decorative quality.

The great office building, The Chile, in Hamburg while built of rough reddish-brown brick has its entire ornamentation developed in molded terra cotta honey-combed forms, both decorative and supporting and of a color and glaze harmonious with the brick. The use of distorted and elongated figures fabricated in glazed and unglazed terra cotta is

strikingly apparent in many of the modern façades throughout the large cities.

For the designer in flat stucco surfaces the craftsman in the potteries, inspired by the creative energy of the new movement has placed in the hands of the architect molded and highly decorative tile in low relief and striking colors. These tile are used as decorative bands in substitution for the projecting and often ugly proportioned cornice or belt mold and also for the window and door architraves and often to form a base course of solid color. An abundant and understanding use of these tile in the manner described is found all throughout the great government building projects in all of the large cities.

The use of decorative paving tile for terraced surfaces, not only flat roofs for recreation purposes but vast ground areas has been brought to a much higher state of development and general use in Europe than in America. In conjunction with raised flower beds with tiled borders they are extremely effective.

Again, the ornamental use of the output of the potteries, many of them subsidized by the government is shown in a striking and original way by the German habit of employing the highly glazed colorful pieces as garden ornaments. An extremely interesting and successful treatment of a long exposition alley at a decorative arts show in Munich employed the placing of groups of life-sized sculptured figures with low flower beds between and clipped bay trees behind as a background, along each side of the long stretch of gravel walks. These groups were created in glazed terra cotta in many colors and the gaiety and happy effectiveness were most agreeable.

In one of the loveliest private gardens in a suburb of Cologne is another effective use of colored statuary. Throughout the garden at points of axis the life-sized colored figures were masterfully placed always with a background of green-black shrubbery. Something of Dresden but bolder and more striking as the scale would demand.

The domestic interior tile of engaging shapes and practical sizes are in common use in modern interiors both as floor surfaces and in conjunction with flat stucco surfaces as the foundation of the decorative design of fire mantles. An extremely amusing and delightfully original use of ordinary roofing tile contrasting in their form arrangement with the common ordinary garden variety of flower pot as a decorative piece for a fireplace was observed in the living room of one of the more promising of the young modern architects of this country.

Thus a rapid survey of the modern architectural work abroad shows a sympathetic and lively understanding between the architects and the craftsman which presages not a new development but a renaissance in the building industry.

Staff Architect
Art Institute of Chicago
Chicago, Illinois

A LESSON IN DESIGN FROM THE SANDHILL POTTERS OF NORTH CAROLINA[1]

By Felix Payant

ABSTRACT

The Jugtown pottery made by the Sandhill potters of North Carolina is described. The design of the pottery is analyzed and the making, glazing, and firing of this ware along with the equipment and raw materials used are described.

In North Carolina a product is made which is known as Jugtown pottery. Throughout the state of North Carolina there are fifteen or more potteries. Some in the western part carry on a tradition of the Indians and are making an interesting sort of ware. The most interesting potteries, however, are those located in what is called the Sandhills and along the highways and byways near Pinehurst, a situation which in itself is rather picturesque. Here is a striking contrast: Pinehurst and the more or less homogeneous group of hotels frequented by the ultrasophisticated on the one hand, while a very short distance away are the extremely naïve folk who ply their craft in much the same manner that man might have employed hundreds of years ago. And from their natural clay and seemingly crude kick-wheels and fired in the large open kilns comes this colorful pottery, thrilling and unusually significant.

To the layman or causal observer, perhaps this North Carolina pottery seems somewhat crude and lacking in refinement. Yet there is much to get from it by way of appreciation, for nothing helps us to understand the more perfected stages of an art or craft more thoroughly than to know of its origin, its inception, its relation to life of a people. Art is intimate with life. It must arise from life, its needs, its ideals; and any art which grows out of art is no longer art but a something else.

So through this brief discussion on this pottery, commonly called Jugtown pottery, it must be kept in mind that this ware is a direct outgrowth of the lives and needs of a very simple people. By keeping this idea in mind, their particular expressions in the ceramic art can be enjoyed much more.

This pottery is the work of a people of few needs beyond the essentials of life. They are at a stage of development comparable to the first settlers in America; in fact this pottery is said to be a survival, not a revival. It should be studied and enjoyed much as are the exhibits of early American furniture and utensils in the Metropolitan Museum of Art.

Then with a sympathetic understanding of these naïve artisans it

[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February, 1928, (Art Division.)

is easy to extend our interests to the more finished ceramics that express the ideals, the lives, and customs of much more advanced or sophisticated stratum of society. The latter demand a greater finish, a finer technique, and display of more skill. This we see in the exquisitely finished pieces of European and American ware which reflect the opulence and grandeur of their respective ages. Some of these have become nothing more than an expression of skill while sight is lost of the fundamental urge.

If the greatest architect in the world were to try to build the most beautiful building in the world, yet a building having no particular problem to solve, no definite purpose, no function, he would necessarily fail, for the greatest beauty is to be obtained in architecture or any other form of art when it answers some great need. It should help release the person from some struggle and to liberate him for some more advanced problem and so on upward.

Just so this Jugtown pottery seems to answer a need perfectly, for by it the problems are solved again. Because these North Carolinians, due to isolation, have changed little in the past two hundred years their art of pottery making has kept this original relation to their lives. It is an execution of an art much as it might have been back in 1740, in the days when their English ancestors settled in this section of the country.

These original settlers found themselves with a need for utensils for carrying on the simplest kind of home-keeping. How was this to be met? They were practically cut off from the outside world. Clay was discovered in the vicinity and of a sort suitable for making pottery. So mankind once more found itself answering a deep felt need by responding to its environment and finding there materials out of which these necessities could be fashioned. This, of course, might have been extremely crude at first while materials were being tried out, but the workman in the manipulation of his materials found that they resisted less and less his touch until they proved not a barrier but on the other hand his inspiration.

At this point, the North Carolinian launched himself as a ceramic artist. For as long as man finds himself limited or repressed by his means of expression he cannot be an artist. But the moment he sees the material whether stone, clay, wood, textile, metal, or what not as an inspiration, then he creates an art. Struggle and consciousness of a medium are bound to cut off the artistic contact, that is, the message that is transferred from the artist to his audience through his creation. In this case it is pottery. It is like the inspired sculptor who sees a beautiful statue in a block of marble and knows that all he needs to do is to chisel off the extra stone.

This rather naïve pottery was a rather beautiful solution of a problem. It gave these simple people the pots they needed for food, plates to eat from, the pitchers and water jars, candle sticks, vases as well as many other accessories as watering devices and bird houses. All through these are traces of the classic tradition which, of course, was inherited from European ancestors. Among these is a type of jug which resembles the amphora of the ancient Romans in which they kept their wines. Closer study perhaps would show more of these and how they have been used to solve new problems, a new adaptation.

Since prehistoric times when the Cro-Magnom man decorated the walls of his caves which we now see in France and Spain to make them more beautiful, man, the artist, has always had the urge to create for himself utensils which not only function well in serving the needs of his routine existence but also his need for beauty and refinement. Excellent examples of this are the refinement of line in the Congo sculpture and the exquisitely fashioned utensils of the Alaskan Indian and the pottery of the Pueblos to be seen in the American Museum of Natural History.

So also in the craftsmanship of these people of North Carolina is found the urge to express refinement. Refinement thus shows itself in the various ways in which the craftsman feels the sympathy of his materials; the way in which he appreciates how the rhythmic movement of the wheel produces a most pleasing texture and decorative effect on the surface; how the various unrestrained curves and lines spring naturally and without restraint.

In the further study of refinement, there is design and its elements, namely, line, mass, value (light and dark), and color; and with these it is easy to analyze the several component parts of art structure, or what is commonly called the elements of design.

Line (any art object) is a subject difficult to abstract. The line of growth may be a contour line or may be an axis or it may be just a feeling, a spirit, maybe the soul of the object, if that expression may be used. In this Jugtown pottery, line in most cases is simple yet strong. It has refinement suitable to the nature of the particular piece.

Line or curves in design are often put into two general classes, the restricted and the free flowing. The former gives the feeling of mechanical restraint while the latter reflects life and is the type seen in nature, as in the unfolding of stems and leaves of plants and contour line of buds and flowers as in the tulip. It is repeated over and over in the human figure. One of its chief characteristics is that no part of it is an arc of a circle. A good example is the difference between a Greek vase and the old-fashioned goldfish bowl. It was particularly noticeable in examining the hundreds of pieces of Jugtown pottery that the con-

tour lines and lines of growth were all the simple free flowing lines. They were never opposite curves, or the curve that doubles upon itself. All of them seemed to have the kind that leads from a substantial base to a pleasant upward movement.

Most of these ceramics are naïve in their mass arrangement, having a dominate body, and few, if ever, are divided into two masses, the handles, lips, cover, and nobs being properly subordinated to the main, thus producing a pleasing unity. It was not until recently that outside sophistication has influenced the simplicity and caused some of the potters to add discordant masses to the otherwise fundamental forms.

Perhaps it is their medium value that makes them very suitable to the homes in which they are used; not causing dark spots or very light, but appearing as unobtrusive as possible in the peasantlike interiors of these homely homes. Many of the pieces by means of glazes have more variety while most of them are all of one value and do not break up the main important mass. Others, through the use of glazes, have two values; yet these values are so closely related that any inharmony is avoided.

The colors of most of these pieces, due to the clays and glazes, are mostly a warm rich yellow, orange, golden brown, and lovely autumnal colors which bring a cheerfulness into the homes and give a psychological pleasure whenever the utensil is used. All the pieces have a nice gradation or transition of color.

The kick-wheels used are of the most primitive type. The glazes are of the simplest sort; red lead and brown sugar produce the warm golden brown, salt for the grays, and sometimes ground glass and charcoal with something else to hold it together. A technical ceramist would get much pleasure from a visit to these people, especially if they have the good fortune to see the Coles family at Steeds, N.C., a branch of that famous family which has carried on this art from generation to generation. The housewife may be seen doing the week's washing on the stones at the edge of the creek. The beautiful sun-bonnetted daughters will be working the potter's wheel, and the father with flowing beard and hair will greet you as you return to the potter's craft of two centuries ago.

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Columbus, Ohio

PAPERS AND DISCUSSIONS

A LABORATORY FOR THE TECHNICAL CONTROL OF THE MANUFACTURE OF REFRACTORIES[1]

By L. J. Trostel

ABSTRACT

A detailed description is given of the laboratories of the General Refractories Co. with an account of the manner in which the laboratory serves in research, operating control, sales help, process and product development, and in collaboration with technologists in coöperative associations.

Introduction

Because this type of laboratory is a comparative novelty among the manufacturers of refractories, a description of the service rendered was thought to have value. It is believed that the problems arising in this company are typical of those of the refractories industry in general, for they have their origin in fifteen different manufacturing units. These plants include five manufacturing silica brick, eight fireclay brick, one magnesite and chrome brick, and one high alumina brick.

Fig. 1.—Outside view of laboratory building.

In addition to the actual manufacturing units, there are the accessory clay and coal mines and ganister quarries which furnish the raw materials, and are prolific sources of concern. The consumers of refractories submit problems, many of them novel, whose solution is frequently far removed from mere differences in the physical aspects of plant processing, and involve a well-founded knowledge of thermochemical mineralogy.

The Laboratory Proper

The laboratory is situated at the eastern works of the company which manufactures chrome and magnesite brick. This location was chosen not so much with the idea of serving this particular

[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February, 1928. (Refractories Division.)

works, but because of necessary proximity to the main offices of the company and the fact that two-thirds of the manufacturing units are located in the State of Pennsylvania. The local plant offers facilities for carrying on plant scale tests after they have passed the laboratory stage, and the large city in which the laboratory is located offers library facilities and the professional contacts that every research organization constantly needs.

The laboratory building, recently completed, is shown at the left in Fig. 1. The building is a fireproof, two-story brick structure, with a deep basement and a roof sufficiently strong that other stories may be added later as required.

The first floor, Fig. 2, is given over to the physical testing section, including a partially equipped process laboratory. The equipment for the former includes a standard A.S.T.M. load-testing furnace, a spalling and reheating furnace, two pyrometric cone equivalent (P.C.E.)[2] testing furnaces, one heated by oxygen and acetylene gas and the other by carbon resistance after Bureau of Standards' design, a special furnace for studying the disintegration of fireclay brick by carbon monoxide, a Navy Department simulative service furnace, and machines for making tensile strength tests, cold crushing, and mechanical screen tests. The process laboratory equipment to date consists of a small three-foot dry pan, gyratory riddle, and a hydraulic press for the small scale manufacture of full size experimental refractories.

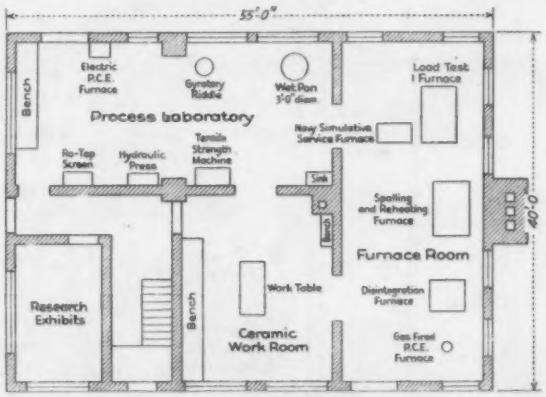

FIG. 2.—First floor plan.

The second floor, Fig. 3, is given over chiefly to the laboratory for tests of a chemical nature, and is equipped with the necessary precision balances, electric muffle furnaces, hot plates, calorimeter, photometer, colorimeter, gas trains, and such apparatus. Forced ventilation and flood lighting are particular features of this section. The offices, files, and library of the laboratory are located on this floor as well.

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[2] A term recently adopted by the A.S.T.M. to supersede such expressions as fusion, softening, melting, and deformation points, *i.e.*, pyrometric cone equivalent.

The location of the chemical laboratory on a separate floor from the physical section insures the cleanliness, comfort, and freedom from dust that intricate mineral analyses and examinations require.

The basement, Fig. 4, is given over to the chemical sample preparation room, storage for test specimens, lockers and showers for the staff.

The Staff

The staff engaged in active experimentation is divided about equally between the chemical and physical sections, though it is rarely possible to define sharply the problems arising in this industry as distinctly chemical or physical.

In practice the chemical section studies the compositions and reactions of the materials involved, both in the crude and finished state, and such constants as affect their usability such as the P.C.E. value, porosity, specific gravity, particle size; and, in the case of fuels, the calorific value.

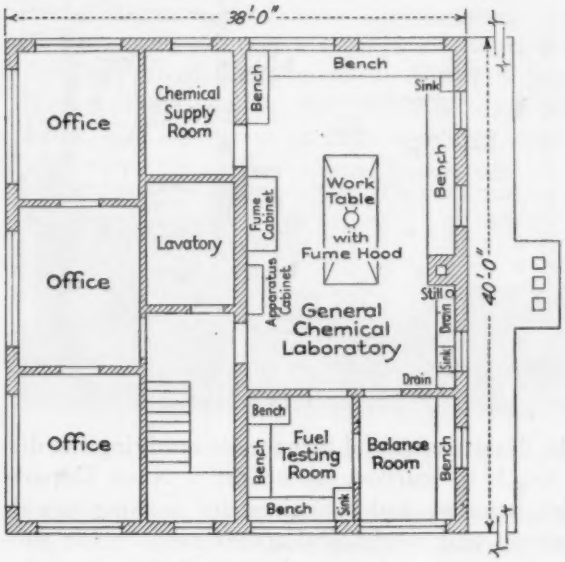

FIG. 3.—Second floor plan.

The physical section, on the other hand naturally studies the results of various combinations of refractory materials as represented by experimental and commercial brick. These necessitate a determination of such constants as are developed in the standard load, spalling, reheating, transverse breaking, and crushing tests. Special tests are necessary from time to time, depending upon the special problem such as thermal expansion at elevated temperature and the effect of the type of slags and gases met in metallurgical applications of the refractories.

The standard tests for refractories of the A.S.T.M. are used in both the chemical and physical sections wherever possible. These tests have received the approval of the ranking refractory technologists of the country, and the use of such approved methods tends to prevent criticism of the value of the test data obtained.

Outline of Activities

The broad general objectives of this particular laboratory are conceived to be (1) uniformity of product, (2) increase in quality of product, and (3) lessening of cost. The various specific lines of activities in which the technical staff engages to achieve these three objectives are (*a*) prosecution of research problems, (*b*) routine control of manufacturing operations, (*c*) servicing sales and operating departments with technical advice and information, (*d*) patent investigation and process development, (*e*) maintenance of professional contacts by activities in certain technical and scientific societies, and (*f*) constant review of the technical literature relating to refractories, making abstracts of the important items and advising those directly interested.

Research

A commercial laboratory, engaged in both research and control work, is necessarily limited in the type of investigations carried on. The large number of projects under way calling for early solution do not permit the time to engage in extended academic research. Accordingly, such investigations into the unexplored fields of the pure science relating to refractories, must continue in such laboratories as those of the Bureau of Standards, the Geophysical Laboratory, and the Universities.

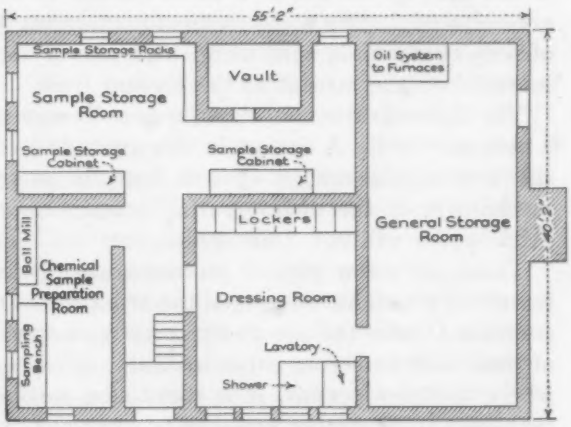

FIG. 4.—Basement plan.

The research projects which engage our attention from time to time originate in (1) the customer or user of the brick, (2) our own production department, and (3) the research staff itself.

Customers' Problems It is our constant aim to coöperate to the fullest extent in the solution of the refractories problems brought to our attention by the users of refractories. Modern manufacturing methods, as we all appreciate, demand constantly greater efficiency so that more steel may be melted, more coke produced, and more boiler power developed than ever before in nearly the same installations. Thus new and unusual demands are made upon the

well-known refractories which necessitate development of different combinations of the common materials and of the newer refractory materials.

A second factor determining a phase of the research work has been the request for special refractories for entirely new processes.

A third factor has been the desire for more differentiation in the type of refractories supplied to old and established processes which formerly proceeded on the idea that the same brick was entirely satisfactory for a number of quite diverse operations.

A fourth factor has been the realization that while in the past the eventual failure of refractories supplied for certain types of industrial operations has been taken for granted, now the attitude is quite the reverse, and the request is made to modify the usual refractories supplied, so that they will not fail.

The trend toward blast furnaces of larger capacity introduces the problem of greater refractoriness in the linings to resist the much increased hot blast required to melt the larger charges. The introduction of the use of soda ash as a metal purifier in the foundry industry has necessitated finding some means for retarding the well-known reaction of soda compounds with silica, which involves nearly every refractory material on the market at the present time.

The disintegration of blast-furnace linings was formerly considered a necessary evil. A change in this attitude has necessitated a study of the iron-oxygen-carbon system both to understand more fully the mechanism of the disintegrating reaction and for the production of brick which will not disintegrate.

These are a few typical problems arising entirely in the use of refractories which have engaged the attention of this technical staff. The continued use of the usual refractory materials depends upon a solution of these and numerous other instances of the same type. Accordingly, where facilities permit, it is the policy to open this laboratory to a customer and together attempt to work out the problem.

Plant Problems The problems which are referred to the laboratory by the production department generally arise from an attempt to do one or more of several things, (1) use raw materials from a new source, (2) institute a new type of processing, or (3) introduce greater efficiency in an established practice.

The acquisition of new clay lands or the discovery of variations in the character of the raw material being worked, necessitate determining the effect of the changed composition on the behavior during processing and the properties of the finished brick.

The introduction of mechanical molding of silica brick, of dry pressing of clay brick, and of tunnel kiln firing, each introduce typical manu-

facturing problems. Reduction of drying and firing breakage are problems in manufacturing efficiency. This involves studies on the one hand of the mechanism of drying reactions with ware of varying composition, of different shapes, and of different types of driers, and in the instance of firing, of the proper setting, of the type and duration of the atmosphere to maintain, the intensity of temperature required at different stages of the firing, the proper fuel to use and an understanding of the particular mineralogical changes desired in the finished ware to produce a refractory of maximum strength and desired size.

It will be apparent from this brief outline of these research activities that three very vital points of contact must be maintained at all times in order to function at the highest efficiency. These are (1) with the user of refractories, (2) with the plants producing the refractories, and (3) with the forward-thinking technical men of the industry who devise the tests and evolve the theories of action of the materials during plant processing and use later in the industries.

Manufacturing Control

The subject of routine plant control is only one phase of our general scheme of technical control. It usually represents the reduction of the findings of the research work of ourselves or others to actual plant practice. In other words, it means that conducting definite periodical tests on our products will point out and insure that the material possesses certain requirements regarding composition, fusibility, thermal strength, size, and other properties. While the idea of research is always fascinating, it should be recognized that regular control of quality of recognized brands must be carried on concurrently.

The biggest problem before the production department at all times is the maintenance of uniform quality. This arises from the fact that a customer, in specifying periodical deliveries of a certain brand, wants to feel certain that he will always be furnished exactly the same brick.

Manufacturers of refractories can accommodate themselves much more easily to the idea of customers buying under specifications if they possess testing facilities for making periodical routine tests. Deliveries are then made with the confidence that rejections are not likely because requirements of the contract are known to have been definitely fulfilled in advance of shipment. At present this laboratory is conducting a number of routine control programs covering our silica, clay, diaspore, magnesite, and chrome products.

The manufacturing control programs now in effect are the result of only a few years' work and are necessarily neither complete nor final. It is obvious, also, that certain control programs may be started because of apparent necessity and then discontinued later be-

cause they are not found to be as valuable as originally conceived, or because they have outlived their usefulness. The need for other programs will occur as studies of manufacturing situations continue.

It may be a trite observation to make, but no control program is worth the effort of continuing unless first there has been shown a decided need for it; second, that the control program really controls; and third, that the program is kept up constantly without anyone "cutting corners" because of a falling off in interest.

Servicing Sales Department

The cases where the laboratory has assisted the sales department with technical information will not be described in detail; but it should be pointed out that the troubles of the sales department originate on the "firing line" where refractories are used, and accordingly present very practical research problems. The solution of these problems by the laboratory eventually results in the production of better products to meet competition, of new products to meet special service requirements in the trade, and of aiding the sales department generally in placing the company's varied line in installations for which they are best suited.

Process Development

From time to time various patented processes or private formulas for making refractory products are offered for sale to the company by outsiders. In addition, individuals within the company have ideas along similar lines. Naturally the company must first investigate such processes or mixtures to determine if they possess all the virtues and properties claimed for them, and cull out the worthless ideas. The laboratory is the point where this "trying-out" or process development starts. If the process or mixture shows promise after passing the experimental stage, it is advanced to full scale production in one of the plants, and subsequent service trials.

Maintenance of Professional Contacts

The further expansion of technical control in the refractories industry depends upon the general advancement of the knowledge of the special chemical and physical properties of the raw materials and their reactions under various conditions of usage as commercial refractories. But the millennium is far distant in this respect. The standard tests are constantly being modified, trying to keep up with the recent advances and altered conceptions of our theories of the action of refractories. The history of the changing spalling test during the last ten years is one instance. Another is the slag test. In spite of the fact that

slag attack is a condition to which nearly every refractory product is subjected, to date, in view of the lack of sufficient knowledge of the thermochemical reactions taking place where refractories are used, refractory technologists cannot recommend a laboratory test which will tell accurately in advance what slag action will take place on a brick in an industrial furnace. Accordingly, in order to maintain a sufficiently broad understanding of the problems of the industry it is necessary for men engaged in technical research of refractories to keep up with the literature in the societies concerned with their products, and to contribute to the free exchange of ideas and information by publishing occasional papers describing the results of completed work which is not considered a necessary trade secret.

General Refractories Company Laboratories
Baltimore, Maryland

BUSINESS MANAGEMENT[1]

By H. K. Ferguson

Introduction

Research work on design and customers' wants is very important and should go near the head of the list of essentials to business management.

Plant Secrecy

One of the first things to make for success in business management is to do away with plant secrecy. A member of this Society thought he had some plant secrets that were the basis of a patent litigation in which he was involved. He was surprised to find that men who were working in his shop appeared in the court room as representatives for the other side of the case. They had been in his plant about a year and one-half. Other friends in ceramics who were actively engaged in a very large business abroad came over to America hugging to themselves the secrets of a bygone generation. It took them about four months to realize that the things they were trying to hide were at least seven to ten years out of date in this country and they had much more to learn by frankness than they had to hide by secrecy. We shall attain more success if we can continue to display frankly the results which we have obtained and those we hope to obtain in our business.

Study

H. L. Gantt has said that the most noteworthy thing about the American business man is his unwillingness to accept the opinions of

[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February, 1928. (General Session.)

others. Leadership is dependent on study and teaching. Therefore, if we can keep these thoughts of studying and teaching and make sure that we are up-to-date in the study of the industries, we shall find that we are stabilizing our positions as leaders.

A man who busies himself in the effort to impress upon his organization that they must follow his leadership courts trouble. There is no sympathy due him because he has simply been going along without proper preparation for leadership. If he were to spend the time necessary to acquire leadership he would be followed automatically.

Leadership used to consist of 90% personality and about 10% study. Today it is almost reversed; 90% study and 10% personality. It is certain that our direction must be quite definite if we wish our plans to be followed.

Research

Research is interpreted to mean not only research in processes, in materials, and machinery, but also in customer contact. Perhaps we cannot give the customer everything he wants but we have to come close to it if we are going to hold his business. Some of the minor variations from standard which enable a manufacturer to hold his customers' business in competition with others are surprising. We are not fighting so much against our competitors these days as we are joining them in a fight against ignorance, waste, and poor management in a way that will be of service to our customers. Research as to what our customers want includes research in design, materials, and factory processes.

Personal Interest

Budgetary control is essential because it is important to know about how far we can go. We shall assume that we have graduated from Gilbreth and Emerson and Taylor, etc., and that we have a personnel in our plants that is willing to coöperate with us; but even then we shall not get ahead very rapidly unless we have what all the champions have, and that is the capacity to have fun in our job. If the work can be planned ahead so that we know what we are to do and can bring to it that thing that comes with good planning, the enjoyment of the work we are engaged in and the pleasure that goes with a job well done, we shall have gone a long way toward making a winning team of our organization.

Distribution

Some men have found it cheaper to bring in raw material by trucks than by railroad. Others find it cheaper to ship finished products a long distance by trucks instead of by railway on account of the high

prices on freight and on finished goods. The country and the railroads are coming to a serious question as to how much more they can raise rates and still hold their business. In that problem of distribution and of warehousing to meet our customers' requirements with material and stock control comes the opportunity for very careful investigation. We can make a thing much cheaper if we have the materials and the men and the equipment all at the right time and place. It is necessary for manufacturers and distributors to give their customers what they want and where they want it.

Take the most successful business in the line we call our own, carefully study and scrutinize both it and our own on the basis of the twelve points given by Prof. Lytle[2] and find out wherein we are falling short of the goal to be attained. Then with fun and enthusiasm back of our job and with the coöperation of the men who are with us, we can make our company one of those which is serving its customers better than it has ever done before.

Discussion

G. A. ROUSH: I spent fourteen years in one of the leading technical colleges in the eastern part of the United States and then substituted for a man on a leave of absence in one of the colleges in the far west. My line was metallurgy. The metallurgy there was of an entirely different type from what I was acquainted with in the east. The operations were in the center of a heavy mining district.

I found some extremely interesting differences of conditions. I had gone through our own alumni register and the alumni registers of other schools in the east and found that after ten years only about 50% of the graduates of the schools were in technical positions where their own training was of prime importance. Our alumni lists showed that after ten years at least 50% of our graduates were not in technical work but were selling insurance, and doing many other things but were not in technical work.

In the little School of Mines in the west I found that more than 90% of its graduates were doing technical work in mining and metallurgy. For some time I could not understand why this was true, but after analyzing the situation the most plausible explanation was that almost all of them without exception worked in mines, not only during their three months holidays but on two night shifts (Friday and Saturday nights) during the weeks while they were in school.

By the time they had tried out one or two years of college work along this line, working at the same time in the mine or in the metallurgical

[2] C. W. Lytle, "Trends in Manufacturing Management," *Bull. Amer. Ceram. Soc.*, 7[7], 174–84 (1928).

plant, they knew whether they wanted to follow that sort of thing or not. They did not have to finish four years of college work and spend a year or two in the plant to find out whether they wanted to stay with that kind of work.

In the colleges in the east we find one of the big difficulties is in allocating the men into the kind of work they want to do. They will say that they want to be chemical engineers. They start at chemical engineering and at the end of the first year they want to shift from chemical engineering over to electrical engineering or from civil engineering to mechanical engineering. At the end of the sophomore year there is another shifting. In the meantime, they have gotten a late start and have to pick up the loose ends. They finally get into something that they think they are going to like and at the end of four years they go out and get work in that line only to find that it is entirely different from what they thought. After a few years of effort, and in many cases of heartbreak, they drop out and go into something else. One good metallurgist was in a high-grade metallurgical work for a number of years, but eventually dropped into newspaper work, and now is selling life insurance. Another one is running a drugstore in one of the coast resorts.

The men should go into the plants during the summer vacations or even carry the thing to a further extreme, as some educators have suggested, and break the college course for a year. Given a year in the plant and after that a final year of college more of the graduates would more surely find the work in which they would be most happy.

H. K. FERGUSON: The break might better occur between high school and college. It would be better for a man to do hard labor in some industrial plant to get the fundamental points of the thing he may have in mind; it would give him an opportunity to find himself. I served my apprenticeship and was qualified to take out an union card at the end of four years, between high school and college, but I finally concluded that the college education would be worth more than the union card.

The biggest furniture manufacturer in this country was graduated at Rush Medical Institute in Chicago. I believe that a year of earnest endeavor, whether between high school and college or during the college course, is the best thing that could happen. For that reason I approve of the Cincinnati and Antioch movements, which give a man a chance to find himself.

I do not care much for the courses where the students are in school two weeks and out two weeks. They interrupt too much. A year out of school and followed by a continuous course of study is recommended rather than constant interruption.

Another point back of it all is that we are not in college to learn how to live, but that we are living while there, as well.

G. A. ROUSH: The best men we have had are the men who have been financially limited and have had to work for a year or two before they come to college. The second best group in a good many cases (and in some cases it is the best group) is the boy who is financially so situated that after one or two years of college he has to drop out one or two years to get enough money to come back.

The difficulty is that the boy, in many cases, is not mature enough to analyze with any degree of certainty what he wants to do. After he has had a couple of years of college and has the fundamentals well laid, he then is considerably more mature and has acquired judgment. I have seriously considered the advisability of making a break at the end of the sophomore year. The student could go out for a year and then come back for his two years of technical work.

A MEMBER: A five-year course with two years of fundamentals and two years of professional study and specialization is also suggested.

G. A. ROUSH: We tried that plan ten years ago without any success.

A. SILVERMAN: We are doing the same thing out in Pittsburgh that is being done in Antioch and Cincinnati: coöperating with industry. It sometimes seems as if it would be better for college teachers to direct self-education in the student rather than to do quite as much talking as we do now; instead of standardizing everything in education, it might be better to get away from standardization, to appraise the individual, and let him progress according to his latent powers and his individual ability, letting the capable individual progress rapidly, encouraging the slow worker, and perhaps making a good man out of him instead of a "flunk." This accomplishes the development of the student according to his individual ability. The slow, steady worker can be used in industry as well as the clear, alert thinker. Men of all types are needed, but above all it is the thorough worker who is wanted whether he is slow or rapid. We have too many schedules and curricula and too much standardization to accomplish this desired thoroughness.

Can education do more for industry by letting the boy work things out for himself in the laboratory; in other words, by becoming a self-reliant individual, so that when he goes out he can face his problems squarely?

H. K. FERGUSON: The one thing that encourages me the most about the relationship of the colleges and their product to our present community life is the fact that they are beginning to realize that they must follow their product after it leaves the institution and find out what relation they are taking to the community and how well they are sustaining the burdens that they ought to carry. For example, in Cleveland, the head of one of the banks said that he had received inquiries from a prominent eastern institution as to the results of five of their

graduates who were in that banking institution, asking about their progress in salary, their strong points and their weak points, and what suggestions the bank had to offer as to improvement in their training in college in order to make more useful citizens of them while they were in school.

Fundamentals cannot be taught by allowing the students to have too much elasticity in the choosing of electives. Those things must be standardized. Ignorance of the fundamentals of business cuts down the market value of the student. Therefore two years of standardization on a forced draft basis are needed. Universities must then consider whether mass production is worth while because mass production presupposes a highly standardized product. The mission of the small college in training the individual to be a useful citizen is a vital subject. Whether a school has a million dollars worth of equipment is not as important as whether the graduate of the school goes out with two years of fundamentals, with a worthwhile contact with community life, and with the impression of his instructors and teachers upon him to make him a useful citizen. He can learn the other things that are necessary to know after he gets out, but if he has that impression, it is going to make him a worthwhile individual.

THE H. K. FERGUSON COMPANY
HANNA BUILDING
CLEVELAND, OHIO

CONTINUOUS ENAMELING FURNACE[1]

BY W. O. OWEN

ABSTRACT

Details are given of the moving of ware through a new continuous counterflow furnace for fusing enamel. Among the advantages of this new type are smaller loss of ware and saving in time and money.

Introduction

The firing of enameled ware economically has always been a problem. In 1919, research work was started in one of the large enameling plants on a continuous method of fusing enamel, which, in the fall of 1923, resulted in the erection of a continuous counterflow furnace. This furnace went into full production in February, 1924, and remained in continuous operation until August, 1927, a period of three and one-half years, at which time it was dismantled and a more modern furnace built.[2]

[1] Presented at the Annual Meeting, AMERICAN CERAMIC SOCIETY, Atlantic City, N. J., February, 1928. (Enamel Division.) Received January 11, 1928.

[2] Considerable material from the old furnace was used in the new one which indicates that the life of materials in such an installation is a relatively long one.

This furnace has been developed during the past four years to the point where it passes from an experimental piece of equipment to a successful furnace recognized as having numerous advantages and effecting considerable savings in fuel, labor, and loss due to rejections. It has been successfully adapted to the fusing of enamel on stove parts, both steel and cast iron, table and cabinet tops, reflectors, refrigerator linings, thermometers, and hollow ware. The furnace is now installed in some of the largest plants of the respective branches of enameling.

The Furnace

The original Beemack furnace was of the counterflow type with two tunnels parallel to each other, each one consisting of drying, preheating, firing, and cooling chambers, and having a common center wall throughout the length. A single continuous chain traveled over the center of each tunnel. The cooling chamber for one chain corresponded to the drying and preheating chamber of the other. These chambers were common in that they were divided by pillars instead of a solid wall so that there was an effective flow of heat from the outgoing cooling ware to the incoming cold ware.

The firing chamber of each tunnel was independently muffled so that each could be operated at a different temperature. In this way ground coat could be fired on one side and finished coat on the other. The firing chamber was completely muffled and the fuel fired beneath the hearth with the products of combustion passing underneath the hearth through the firing and preheating chambers. Automatic temperature control was used. The ware traveled through the furnace on tools or hangers which were suspended by alloy rods from the conveyer. The conveyer chain was cooled by means of a patented air-cooling arrangement.

Later furnaces although greatly improved are designed on this same general principle.

Procedure

The general procedure when using this furnace for ware which needs no brushing or rimming is to dip the ground coat and after the surplus enamel has drained off to hang the ware on the conveyer. It then travels through the drying, preheating, firing, and cooling chambers. As it comes out of the furnace the material is inspected and then sprayed with the finished coat. It is then replaced on the conveyer and passed through the same chambers, but counter to the travel of the ground-coat side.

Furnaces have now been designed of the single-flow type as well as of the counterflow type. The single-flow furnace is more particularly adaptable to those plants which have a small capacity and do not warrant the installation of the larger counterflow type, or in some cases

to plants which are designed for straight line production. The single-flow furnace operates primarily on the same principle as the counter-flow but does not have the tremendous advantage of obtaining heat from the cooling ware to dry and preheat the cold ware. The efficiency of the single-flow furnace is only about 50% that of the counter-flow so that in deciding just which type should be used this difference in efficiency must be taken into account. The counterflow furnace should be used whenever possible.

In adapting this furnace to various types of enameled ware it was found that the labor savings to be obtained by continuous operation could not be fully realized due to an intermediate drying being required so as to brush or rim the ware before firing.

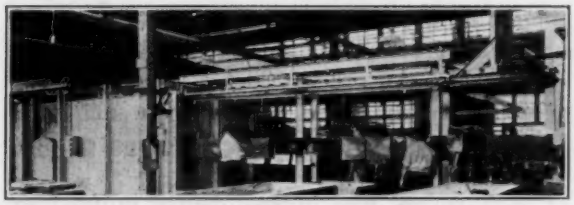

FIG. 1.—Continuous enameling furnace fired with gas and equipped with a continuous conveyer. Work is dipped for the ground coat and is hung on the conveyer and carried into the furnace when the enamel is fired on. Issuing from the other end of the furnace, the work is given a finish coat and is returned to the furnace for the final fusing operation.

With this fact in mind a new design was developed using auxiliary driers constructed beside and parallel to the enameling furnace. A double-chain conveyer is used with each chain passing through a separate drier. Waste heat or products of combustion from the furnace are used as the heating medium. With this arrangement the following procedure is used. The ware is dipped, hung on the conveyer chain, and passed through the drier. As it comes out it is removed from the conveyer and brushed or rimmed, as the case may be, and then replaced on the conveyer. It then passes through the drying, preheating, firing, and cooling chambers. A considerable amount of labor has been saved by this arrangement. One particular furnace of this design has a capacity equal to seven 5 by 12 batch type furnaces, operates sixteen hours a day instead of twenty-four, and has a direct labor charge of only eight men who unload the finished ware. All the trucking and handling of material which formerly was necessary from dipping and spray booths to the driers and to the furnaces has been eliminated as well as loading material from drying racks to forks and unloading from forks to racks.

One of the disadvantages of a single continuous chain was that since the rate of firing is entirely controlled by the rate at which the ground coat must be fused, the furnace capacity was dependent upon the rate

of firing ground coat. This has been overcome by the use of the double conveyer as each one has its own driving and variable speed mechanism and thus can be operated as an independent unit. It has been found that the finishing-coat side of the furnace can handle approximately twice the amount of work of the ground-coat side.

Advantages

The relatively slow heating and cooling action to which the ware is subjected is advantageous in that material which is warped when it enters the furnace comes out straightened, and that work varying in steel base as much as four gages can be run through at the same time. This seeming anomaly is explained by the gradual heating of the ware. It is well known that enamels will mature at definite temperatures in a given time if the heat is of a greater degree than that at which fusion occurs. If the steel base is close to the same temperature, the enamel will fuse regardless of gage. There are, of course, limitations to the range of gage that can be worked in the furnace at the same time.

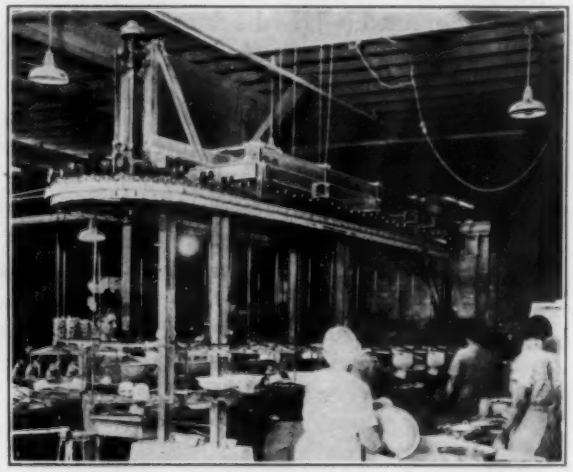

FIG. 2.—Dipping and loading ground coat on idler end.

Gas, or a combination of oil and electricity, or electricity can be used as the heating medium in this type of furnace. Where gas is used automatic proportioning firing equipment is used with automatic temperature control. In the combination oil and electric, the electricity is used as the control. When electricity is used alone the furnace has no muffle, the elements being placed directly in the working chambers. The loss due to gasing has been reduced especially where gas is used. In some instances the ware has been fused in the presence of products of combustion with no noticeable effect on the luster of the product.

The maintenance cost on this type of furnace is very low. The only parts which might be subjected to destruction are the chain, tools, and hearth. The chain which was used on the first Beemack furnace four years ago is now being used as one of the chains on the new furnace and shows no signs of destructive action. The life of the tools is con-

siderably over a year. The life of the hearth, it has been found, depends to a large extent upon the material used and the treatment to which it is subjected in the furnace.

Research work has been conducted on various types of heat-resisting material and different types of construction resulting in a new design of muffle which it is believed has a longer life and a greater heat conductivity than that formerly used. With this design a higher furnace efficiency has been obtained and the length of the furnace required for a definite capacity has been reduced 10%. This design has not been in service long enough to state definitely what can be expected of it. Indications, however, point to a much longer life than has been previously obtained in hearths or muffles.

The speed of the conveyers can be closely regulated so as to obtain the desired fusing time for the ware being enameled. This, together with controlled temperatures, allows the furnace to be operated on a definite time-temperature schedule. Thus the combination of conditions which produces the best quality of ware can be determined and closely adhered to. This eliminates dependence upon the human element insofar as the actual fusing procedure is concerned.

Contrary to popular opinion, this furnace is readily adaptable to small plants as well as to large. There is at present a single-flow furnace having a capacity of only 200 square feet per hour. This is the smallest installation. The largest installation is one which has a capacity of 4200 square feet per hour.

Summary

This summary sets forth some of the more important advantages of a continuous furnace; (1) constant temperature, (2) definitely controlled firing time, (3) elimination of trucking, (4) elimination of furnace men, (5) reduction in fuel, (6) lower maintenance costs, (7) fewer rejections, (8) reduction in the handling of ware from the time it is sprayed or dipped until it is fired, (9) saving in floor space required, (10) standard time temperature treatment for each class of ware, and (11) loading capacity of 3 to 7 sq. ft. per foot of conveyer depending upon ware.

Surface Combustion Company
Toledo, Ohio

ACTIVITIES OF THE SOCIETY

YOUR MEMBERSHIP STATUS

Fall is here, the torrid days are past, and most of us are recovered from vacation fatigue. All of us are forecasting a program for personal advancement. Several wise ones have put prominently in their "self advancement" schedule, "active coöperation with their fellow ceramists for the promotion of ceramic art, science, and technology."

The week of February 4, 1929, Stevens Hotel, Chicago is the next big coöperative event. A week of meetings, plant visits, and ceramic exposition.

You have received a folder giving the layout for an exposition of ceramic products. Will you follow this with a personal appeal to your firm and those in your neighborhood to take space? Send for more folders and help put this across in a big way.

And the program of technical papers: this is being planned in conjunction with the trade associations. Will you economize in expense and energy by sending the title and abstract of the papers you will present? This is needed for your benefit.

And membership support of this work—do you realize that there are several persons who are applying for membership unprompted by any other than a desire to belong to this coöperative SOCIETY? Members are wanted, not for financial support, but to make of this SOCIETY a real factor in the progress of ceramic art, science, and technology.

Here is the present membership status. Will you secure a corporation and a personal member?

MEMBERSHIP STATEMENT

Memberships	January 1, 1928	Members (New)	Gross Totals	Resignations	Net Total August 1, 1928
Personal	2191	138	2329	42	2287
Corporation	309	8	317	7	310
Honorary	9	6	15		15
Life	2	1	3		3
	2511	153	2664		2615

And your monthly *Journal:* the comments received at the executive offices are mainly from nonmembers. Examples of these comments are "how can the SOCIETY get such solid material together, how do you abstract the world's ceramic literature so exhaustively, how can you afford to print so large a *Journal* on such a low membership fee, etc."

As a member you have every reason to be proud of your *Journal.* Do you know how much you have had this year? Here it is in comparison.

Record for the Journal

Pages Printed to August 1 Each Year

Year	*Journal*	*Abstracts*	*Bulletin*	Tota
1925	546	238	414	1198
1926	554	264	352	1170
1927	650	364	252	1266
1928	658	586	252	1496

There have been some mighty nice comments about the abstracts. Many have said that they were worth several times the membership cost. And have you noted their increase in thoroughness and value?

Now, (1) are you going to put into your schedule for self advancement "active participation in the AMERICAN CERAMIC SOCIETY"?

(2) Are you going to help put over the Exposition of Ceramic Products in Chicago next February?

(3) Will you plan one or more papers for reading at the Meeting?

(4) And will you extend to your associates, friends, and neighbors an invitation to participate in this thorough going coöperation for the promotion of the ceramic arts, and sciences and technology—your AMERICAN CERAMIC SOCIETY.

NEW MEMBERS RECEIVED FROM JULY 1 TO AUGUST 1

PERSONAL

Hildegard Brauer, 13915 Kinsman Rd.. Cleveland, Ohio, Designer and Modeler for Pottery.

Francisco Gardon, P.O. Box 496, San Juan, Porto Rico, Architect and Owner of Ceramic plant.

Alex Kramar, Paltavskaya, 8, Kharkoff, U.S.S.R., Chief Engineer, Ceramic Division, Silicate Trust of Ukrania.

Gregory L. Rogers, 1500 1st Ave., S., Seattle, Wash., Ceramic Engineer, Gladding. McBean & Co.

STUDENT

Alan L. Gormly, Mt. Vernon, Iowa, Iowa State College.

Membership Workers' Record

Personal		Student	
S. Geijsbeek	1	Paul E. Cox	1
M. Nikonoff	1		
Office	2	Grand total	5
Total	4		

NEWS FROM MEMBERS OF THE SOCIETY

H. F. Eilers, formerly with the Rhode Island Division, Corning Glass Works, is located at Kingsport, Tenn., with the Blue Ridge Glass Company.

E. E. Geisinger of the Pfaudler Company, Rochester, N. Y., will be in Germany for the next year with the Pfaudler Werke, A. G., Schwetzingen, Baden, Germany.

Arthur F. Gorton, who has been teaching at Occidental College, Glendale, Calif., is now assistant meterologist, Scripps Institution of Oceanography, Univ. of Calif., located at La Jolla, Calif.

John Grainer, formerly with the Grand Rapids Vitreous Enameled Products Co., Grand Rapids, Mich., is now with the Ferro Enamel Supply Co., Cleveland, Ohio.

Samuel E. Hemsteger has moved from Middletown, Ohio, to 2801 Preble Ave., Pittsburgh, Pa.

Kai-Ching Lu, who received his Ph.D. Degree in ceramics from Ohio State Univ., in June is employed in the laboratories of the U. S. Gypsum Co., research laboratory, 23 S. Robey Street, Chicago, Ill.

J. Donald Pearson of Erwin, Tenn., has moved to East Liverpool, Ohio.

A. E. R. Westman has resigned as research associate in the Ceramic Engineering Department, Univ. of Illinois, Engineering Expt. Station and has accepted a position as Associate professor of ceramics and research associate, Rutgers Univ., New Brunswick, N. J.

David C. Zimmer is employed as ceramic engineer by the John Douglas Co., of Cincinnati.

CERAMISTS' TOUR ABROAD

Letters from the tour members are unanimous in statements that the tour was an immense success from every standpoint. A steady pace was maintained by which large mileage was covered, many factories visited and several hundred ceramists made friends. Letters and photographs from abroad are just beginning to come in, and judging from the inquiries by post and wire, there is a very general interest in America concerning the tour.

From time to time, notes and photographs will be published showing how the party was received, what they saw, and how the hosts abroad received the tour. An editorial is given here, taken from the *Staffordshire Sentinel*, the words of welcome by Dr. Harkort, a partial report of the visit to Stourbridge, England, and some photographs.

Address of Welcome by H. Harkort[1]

June 13, in Albrechtsburg Castle, Meissen

When I say "hearty welcome" to our American guests in the name of the German Ceramic Society and when I thank the official delegates and the press for their participation in this meeting of ceramists of the New and Old World, I do not wish to do so on the basis of a common congress. I want it to be personal. I do not want to give this welcome the character of a superficial "shake hands" of fellow ceramists who meet by purpose. I want to give it a higher and farther reaching meaning. This meaning we have already expressed by holding this meeting in these, I should say, sacred ceramic rooms. No place in Europe is so befitting for such a ceramic event as is Albrechtsburg Castle.

FIG. 1.—One row of ceramic tourists resting on board the Tuscania enroute home.

Let us remember that two centuries ago the first porcelain manufactory was built here; that inside of these walls the first great ceramist worked. For that is what we must call Johannes Böttger, not only because he invented porcelain, but for his nearly inexhaustible ingenuity to find out new inventions by which he mastered the ceramic problems which he met. He not only strove to bring the scientific and the technical to a perfect state; he also felt the artistic character of his invention. By him ceramics was freed of dependence on the east and the way was cleared for further development which up to that time was of a subordinate importance. Ceramics is a problem of civilization and on this is founded all ceramic development in Europe and America.

FIG. 2.—Cathedral in Beauvais.

But this development in ceramics up to the present day may be valued not only by its extension; it also has to be taken as a tremendous change in creative powers. To consciously understand the great interval

[1] President, German Society.

FIG. 3.—One-third of party at Palace Versailles.

FIG. 4.—One of the groups at Potsdam, the Kaiser's castle.

FIG. 5.—Clay pit, Slovakian Brick Company Hodonin, Czechoslovakia; photographed by Eben Rodger, Jr.

between those days and now, I should like to remind you of the following facts: Böttger's great invention was made while practically in imprisonment and under the oppression of a sovereign who, although he recognized the value of Böttger's work, was without consideration. This castle had been isolated from the world by a permanent military guard.

FIG. 6.—The reception committee in Beauvais.

Of the two technical assistants of Böttger, one only was allowed to know the preparation of the body and the other the firing of the ware. This was a kind of mysteriousness under government protection which perhaps would go too far even for the most anxious minds of today. "Hobnobbing among ceramic plants" had not been invented yet and was still absolutely unknown.

And today! Work in common, interchange of ideas, mutual furtherance, this, I suppose, is the meaning of our meeting today; our becoming acquainted with each other. The American with his easy optimistic comprehension has farthest opened the doors for interchanging ideas and has carried off the walls of isolation from the world around. Ceramic science and technic are no more inclosed by castle walls; they are open to the world.

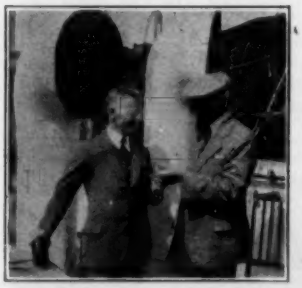

FIG. 7.—Returning aboard S. S. Tuscania. Chas. Garwood and Ed. Hettinger discussing the relative merits of perfume bottles and colored goggles.

Today we are on the eve of removing the barriers which separate the nations from each other. We know that a single person wholly dependent on himself cannot bring work or practical development and that it is only by interchanging ideas that permanent progress in each industrial branch can be made. It is for this reason that you have come from America to make the interchange an international one.

We should work in common; the ceramists of all countries should work together that their products shall reach the highest technical perfection. Furthermore, that ceramics may reach the greatest possible importance as an economic factor we must work openly together.

This may be the idea and the profit of the meeting of today: "Hobnobbing among the nations."

FIG. 8.—A market place in Lucerne.

American Ceramists' Visit[1]

One of the best features of industry today is the exchange of knowledge. Take the two principal industries of North Staffordshire—pottery

[1] *Staffordshire Sentinel*, June, 1928.

and mining. In the latter, for more than half a century, there has been a constant interchange of knowledge, not only between the mining men of this coalfield through the medium of the North Staffordshire Mining Institute, but also between the engineers and research men of this and other districts and between affiliated Institutes. The mining people have always been renowned for their frankness in the exchange of experience and discovery.

In the pottery industry there used to be a closeness and secrecy as to methods of fabrication and as to production which had its root in tradition, going back, indeed, to the days when the Elers wrought furtively at Bradwell Wood, fearful of their processes being discovered, as, of course, they were, for the very reason of the guard which was placed upon them. Nearer our own day, when rule-of-thumb methods and empirical working still ruled the industry, recipes and patterns were conserved like the dread secrets of a grim prison house. Still closer to our time, at the first of the Pottery Fairs, almost every firm confined its exhibits in a sight-proof cubicle and set a sentry at the door. All that is past.

FIG. 9.—Refreshments before "Doing" Karlstein Castle.

Of course, firms have their own processes and technical methods which they would be fools to announce by loudspeaker, and they have their new shapes and patterns which obviously they do not publicly exhibit till the appropriate time. Nevertheless there is a constant interchange of ideas, inventions, results of research, and experiences of difficulties overcome and problems remaining to be solved. And the Ceramic Society, now a quarter of a century old, though youthful by comparison with the learned societies of the mining industry, has specially fostered this give-and-take of knowledge. More important still, it has done more than any other institution to replace the old methods of trial-and-error by scientifically calculated technique. And in that work two men have done more than any others, Mr. Bernard Moore, the most eminent potter in the world, and Dr. Mellor, the foremost ceramic chemist.

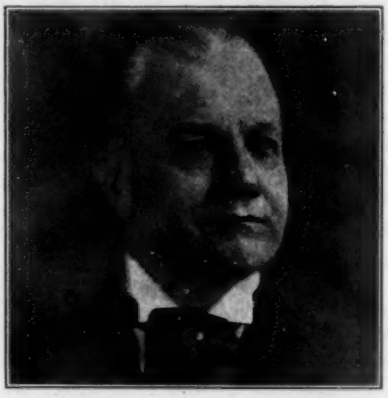

FIG. 10.—P. Malcolm Stewart, O.B.E., J.P. A royal host to the party.

How times have changed is demonstrated by the visit of the members of the AMERICAN CERAMIC SOCIETY. In the potteries tomorrow they will be given the freedom of the factories and access to our processes and productions. Yet they are foreign competitors; at least, in the sense that they are largely manufacturing for their own country, and for others also to some extent, what we previously made for them. But there is no jealousy, only healthy rivalry. The potteries of America

are hospitably open to English visitors, and ours are equally available to them. There is only mutual gain by interchange of experiences.

The American potters can teach us something on the side of mass production, factory organization and business methods, though they have the advantage of constructing and expanding a new industry, starting where we have reached by generations of development. But the Americans can learn also from us, as they have already acknowledged, and will do so still further after tomorrow's tour of the potteries. They will certainly pay tribute to our craftsmanship and the superb technical and artistic attainments of our finest ware; and, in regard to our newer factories and even old ones modernized, they will probably agree that we are not behind the times.

FIG. 11.—Auguste Delaherche, studio potter, Beauvais, France.

In the last quarter of a century, especially, we have made great strides in scientific potting, and we have marked obvious progress in design and artistry. In the same period our American confreres have notably advanced their industry by enterprise, technical and commercial ability, and organizing capacity. The quality of American pottery is immeasurably higher in technique, and better in design, than it was even ten years ago. We pay them this tribute, not patronizingly or in depreciation of our own productions, but by the privilege of seniority in the industry.

FIG. 12.—Dr. Nicola Moufang, Director der Staatlichen Porzellan Manufacture, Berlin.

We of the Staffordshire pottery trades cordially welcome the American ceramists among us and give them, if not the statutory freedom of the city, the freedom and hospitality of the whole industry.

Visit of American Ceramic Society to Stourbridge District[1]

Welcome by the Mayor

A section of the AMERICAN CERAMIC SOCIETY now visiting Europe attended the works in Stourbridge district on Tuesday, and luncheon followed at the Talbot Hotel, the Mayor (Alderman L. J. Cook) according a welcome to the members. Those interested in the glass trade visited some local works in the morning. They were first taken to the Amblecote works of Messrs. T. Webb and Corbett, Ltd., where they were received by Mr. Herbert Webb and others associated with the company. They were escorted round the furnaces and through the cutting shops, and expressed great admiration of the Stourbridge productions. They were entertained

[1] *County Express*, June, 1928.

FIG. 13.—Banquet given by Stourbridge Firebrick Manufacturers and Thomas Webb and Corbett; Stevens and Williams (Glass) Eveson & Co., and John Stevens Co. (Enamel).

FIG. 14.—The Heavy Clay Group at Homer Hill Works of H. J. and J. Pearson, Ltd., Stourbridge.

to refreshments before they left for Brierley Hill to visit the Moor Lane works of Messrs. Stevens and Williams, Ltd., where they had an excellent time. They were exceedingly interested in Mr. J. S. Williams-Thomas, O.B.E., the veteran principal, and the productions of his world-famed company. There was a little speech making after the comprehensive tour of the works and show room, and the spokesman of the visiting party said they had seen nothing finer during the whole of their tour of Europe.

Others of the party visited three plants of Messrs. E. J. and J. Pearson, Ltd., Brierley Hill. At Homer Hill (Cradley) they inspected the making of tank blocks for the glass trade, and also other processes; and at the Amblecote works they saw the continuous Belgian kiln which has been burning fire brick at high temperature and remarkably low fuel consumption for a number of years. At the Delph works they showed most interest in the tunnel kiln, which has been installed about 18 months. They were greatly interested in the sight of so many women workers.

FIG. 15.—Before the Queen's Palace in the Woods, Holland.

The Luncheon

The invitations to the luncheon had been issued by Lieut.-Colonel C. W. Thomas (Messrs. E. J. and J. Pearson, Ltd.), who is a member of the AMERICAN CERAMIC SOCIETY, and a vice president and past president of the English Ceramic Society and he presided. Others present from the district included the Mayor, the Town Clerk (Mr. G. Ince), Messrs. J. S. Williams-Thomas, O.B.E., H. Webb (who was vice chairman), J. T. Price, G. V. Evers, H. Dunn, T. Allen (Dudley), W. H. Silk, G. H. Pearson Perry, A. H. Pearson, J. P. Eveson, G. H. Eveson, C.C., G. R. L. Chance, M. H. Edwards, H. E. Garratt, R. H. Bucknall, C. R. F. Threlfall, Pearsall and W. Fullwood (who had acted as secretary for the visit).

The Mayor's Welcome

The Mayor said that he should like to welcome them as a SOCIETY, as individuals, and many of them as citizens of the great republic across the sea. He hoped that they

had found their visit pleasant. He was told that they had been favoured with excellent weather on most of their trips, and he hoped it would continue to the end of the visit. He hoped the visit would be fruitful, both in results and in interest, and that they might carry away with them happy recollections of the visit and deep impressions of the works and manufactures which they had seen. That morning had been cloudy, but it had brightened up for them, and he hoped that would be so for the future of the Society.

Mr. Amos Potts said the graciousness of the welcome and the friendliness displayed made his response very difficult. The majority of them were of English descent, and were there somewhat as prodigal sons. His ancestors left the neighborhood 300 years ago, and it was with considerable emotion that he responded to the welcome. On behalf of the members of the group present, he wished to thank the Mayor and all the gentlemen who were helping to entertain them. They thoroughly appreciated their efforts, and would always remember their visit to Stourbridge and to the plants of the vicinity.

A Big Society

Mr. H. Webb proposed "The AMERICAN CERAMIC SOCIETY," and said the organization was a very big one, with over 3,000 members, and embraced the china and earthenware trade, the glass and enamel trades, and the fireclay trade. There was nothing quite as big in this country, and no doubt some of the members were surprised to find the smallness of the plants in Stourbridge district. But in that district they were not as fortunate as the people of the States, for they had no "fence" round their market. He hoped the SOCIETY had enjoyed this visit. It had been a great pleasure to see them, and he was sorry the visit was such a short one, as he would have liked them to see some of the places of interest and beauty. He pointed out that crystal glass (glass made of lead) originated in Stourbridge district in the 17th Century, and that the workmen were so much sought after from all over the world, and particularly from Germany, that an Act of Parliament had to be introduced to prevent them leaving the country, and to keep the industry in progress. Whether the glass trade came because of the fire clay in the district, or whether fire clay was found as a result of the glass trade coming he could not say.

A Busy Round

Dr. Silverman (University of Pittsburgh) responded, in the absence of Mr. M. C. Booze (president of the SOCIETY), who was in London. He said on their visit they had been dined and wined, and had been shown one interesting sight after another, and had been given everything but the opportunity to sleep. They hoped to do that when the journey was ended. Their reception had exceeded all their anticipations. They had the birthplace of the glass industry, they had art, and they had the fountain of youth, for in Mr. Williams-Thomas they had the youngest man he had met for many a day. He trusted that the friendship that had begun between England and the States would crystallise and last eternally.

NOTES AND NEWS

COLLEGIATE STUDY OF CERAMIC ARTS

A Dream Come True

America now has a collegiate course in ceramic industrial arts. This has long been in the hearts and minds of many leaders of the industry.

Europe has several schools in which artisans are trained and their training is thorough. Many of the old world masters in ceramic artistry obtained their foundational

training in these schools and some of these schools are now giving instruction in ceramic mixtures and processes but none of them give instruction of collegiate grade.

And in America we long have had courses of instruction in ceramic art. The New York State School of Clay Working and Ceramics at Alfred was the pioneer and the graduates of this New York ceramic art course are in high schools, colleges, and institutes in nearly every state of the union giving instruction in pottery making. The Trenton, Chicago, Cleveland, Cincinnati, Philadelphia, and New Orleans schools have for several years given instruction in ceramic art. Last year the University of Cincinnati and this year the University of Oklahoma have offered formal courses in pottery art with laboratory facilities and instructors qualified to give instruction in compounding, forming, and decorating pottery.

Iowa State College, Columbia University, University of Washington, University of North Dakota, Pratt Institute, Schenley High School, and others have for several years given instruction in ceramic art, the graduates becoming instructors in public schools.

The influence of these ceramic art schools has indirectly been beneficial to the ceramic industries. A recognition of the benefit of such ceramic art schools to industries is found in the endowment by Mr. Hottinger of an Industrial Art School in the Art Institute of Chicago, a recognition of the need of instruction in ceramic arts by the American dean of terra cotta manufacturers that is of immense significance.

But in none of these schools is the training directed to preparing the graduate for industrial leadership and plant management.

Those ceramic companies which are holding place in the front line of industrial progress have leaders who know how to obtain the latest and best materials, mixtures, and processes and in addition have ability to conceive the type and style of ware that will obtain a market demand. Market demands, like styles, are changing rapidly. Purchasers are demanding surface texture, color, and form together with quality that will withstand specific usage; with an increasing emphasis on quality.

What the service engineer is to ceramic industrial product manufacturers the ceramic artist, trained at Ohio State University, will be to manufacturers of the clay, glass, and vitreous enamel products used in households and in construction.

Manufacturers of terra cotta, wall tile, floor tile, roofing tile, face brick, etc., have in the past been a drag on the architects. Artistic creations in architecture were not so readily executed by ceramic manufacturers as they are today with the present employment of the ceramic technologist. But even with the ceramic technologist in the plants the architects are yet handicapped unless perchance the technologist is himself an artist or closely associated with an artist. Those manufacturers of building material who have employees who can conceive and execute architectural effects are the ones who are most favored by the architects.

The art and utility potters who are without aggressive ability for product conception are "followers" and "copyists." Artists can be developed in the shops to decorate very cleverly but a ceramic artist who can conceive, produce, and decorate new ware has not heretofore been trained and only occasionally have our American works found a man who had the technical and the artistic ability to create new ware, to appreciate and fill the technical and artistic requirements wanted by the trade. We have such men in the ceramic industries but they are found by chance, and only by chance have they had opportunities to develop both technically and artistically.

As salesmen and plant operatives, with the combined training provided in the Ceramic Art School at Ohio State University, the graduates will soon find openings and the industries which employ them will secure leaders that will make business more steady and more profitable.

The physical set up and personnel of the Ceramic Art School at Ohio State University are given in the subsequent items. To begin the work the University has spent $15,000 for equipment and will build and equip apace with requirements.

CURRICULUM LEADING TO THE DEGREE OF BACHELOR OF CERAMIC ARTS

The curriculum in Ceramic Art is planned to train artists with a working knowledge of ceramic technology. The essential practical processes used in manufacturing pottery and porcelain products are included and the arrangement of laboratory courses permits sufficient concentration to meet the demand for highly specialized artists in the various ceramic fields.

NOTE: The numbers in parentheses designate particular courses. The figures after those in parentheses indicate the number of credit hours.

FIRST YEAR

Autumn Quarter			Winter Quarter			Spring Quarter		
Engineering Drawing (Principles)	(401)	4	Engineering Drawing (Principles)	(402)	4	Fine Arts (Freehand Drawing)	(421)	5
English (Composition and (Reading)	(401)	5	Ceramic Engineering (Occurrence and Properties of Clays)	(401)	4	Mathematics (Plane Trigonometry)	(431)	5
Chemistry (Elementary or General)	(401 or 411)	5	Chemistry (Elementary or General)	(402 or 412)	5	Chemistry (Qualitative Analysis)	(403 or 413)	5
Military Science		1	Military Science		1	Military Science		1
Physical Education		1	Physical Education		1	Hygiene	(400)	1
						Physical Education		1

SECOND YEAR

Fine Arts (History)	(451)	5	Fine Arts (History)	(452)	5	Fine Arts (History)	(453)	5
Fine Arts (Advanced Freehand Drawing)	(423)	5	Fine Arts (Design)	(431)	5	Fine Arts (Design)	(432)	5
Mathematics (College Algebra)	(432)	5	Ceramic Engineering (Bodies, Glazes, and Colors)	(605)	4	Ceramic Engineering (Winning, Preparation, and Forming)	(405)	4
Military Science		1	Military Science		1	Military Science		1
Physical Edu. (Women)		1	Physical Edu. (Women)		1	Physical Edu. (Women)		1

Summer Quarter: Industrial Experience

THIRD YEAR

Fine Arts (Water Color)	(441)	5	Fine Arts (Thesis Design)	(434)	5	Fine Arts (Life Drawing)	(424)	5
Fine Arts (Modeling)	(461)	5	Fine Arts (Modeling)	(462)	5	Fine Arts (Technical Problems)	(467)	3
Fine Arts (Technical Problems)	(465)	3	Fine Arts (Technical Problems)	(466)	3	Fine Arts (Ceramic Art)	(482)	5
Fine Arts (Ceramic Art)	(480)	5	Fine Arts (Ceramic Art)	(481)	5	Fine Arts (Ceramic Art)	(483)	5

Summer Quarter: Industrial Experience

FOURTH YEAR

Fine Arts (Proseminary)	(657)	5	Fine Arts (Proseminary)	(658)	5	Fine Arts (Proseminary)	(659)	5
Fine Arts (Advanced Technical Problems)	(661)	3	Fine Arts (Advanced Technical Problems)	(662)	3	Fine Arts (Advanced Technical Problems)	(663)	3
Fine Arts (Ceramic Art)	(484)	5	Fine Arts (Ceramic Art)	(485)	5	Fine Arts (Ceramic Art)	(486)	5
Elective		5	Elective		5	Elective		5

DESCRIPTION OF COURSES

Fine Arts

421. Elementary Freehand Drawing. (Five credit hours.) One Quarter. Autumn, Winter, Spring. Five two-hour laboratory periods each week. Ceramic Art, first year. Miss Walker, Mr. Lewis, Mr. Rannells, Mr. Frey, and assistants.

A technical course in the principles of drawing, with special regard for directness and facility. Practice in freehand perspective and values in monochrome. Clay modeling.

423. Advanced Freehand Drawing. (Five credit hours.) One Quarter. Autumn, Winter, Spring. Four three-hour laboratory periods each week, with weekly problems.

Ceramic Art, second year. Prerequisite, Fine Arts 421 or 401–402–403. Miss Robinson, Mr. Rannells.

Drawing from still life and the antique as a means of expression, emphasizing the various possibilities and limitations of the black and white mediums, with problems in composition.

424. Drawing from Life. (Five credit hours.) One Quarter. Autumn, Winter, Spring. Four three-hour periods each week, with weekly problems. Ceramic Art, third year. Prerequisite, Fine Arts 423. Mr. Wiser.

Drawing from the living model with lectures and problems in surface anatomy.

431. Elementary Design. (Five credit hours.) One Quarter. Autumn, Winter, Spring. Two lectures and three two-hour laboratory periods each week. Ceramic Art, second year. Prerequisite, Fine Arts 423 or equivalent. Miss DeBra, Miss Walker.

The principles of pure design, with practice in the presentation of organic design problems. Lectures, conferences, and technical work.

432. Intermediate Design. (Five credit hours.) One Quarter. Autumn and Winter. Three three-hour periods each week, with outside requirements. Ceramic Art, second year. Prerequisite, Fine Arts 431. Miss DeBra, Miss Walker.

Special problems in design, theory, and presentation. Ceramic, textile, metallic, stone, wood, and combined materials are considered for decorative and structural elements.

434. Thesis Design. (Five credit hours.) One Quarter. Winter and Spring. Ceramic Art, third year. Prerequisites, Fine Arts 424 and 432.

441. Water Color Painting. (Five credit hours.) One Quarter. Autumn and Spring. Three three-hour periods each week, with weekly problems. Ceramic Art, third year. Prerequisite, Fine Arts 431. Miss DeBra.

Painting from still life, models and landscape. The purpose of this course is to develop the color sense and ability in the technique of water color painting. Lectures, laboratory work, and criticism.

451. History of Classic Art. (Five credit hours.) Autumn Quarter. Five lectures each week. Ceramic Art and Landscape Architecture, second year. Not open to Freshmen. Mr. Fanning.

The study of the art of Greece and Rome, with some consideration of Egypt, Mesopotamia, and Crete. Illustrated lectures, reading, and reports.

452. History of Medieval Art. (Five credit hours.) Winter Quarter. Five lectures each week. Ceramic Art and Landscape Architecture, second year. Prerequisite, Fine Arts 451. Not open to Freshmen. Mr. Fanning.

From the origins of Christian Art in Rome to the end of the Gothic Period. Illustrated lectures, reading, and reports.

453. History of Renaissance Art. (Five credit hours.) Spring Quarter. Five lectures each week. Ceramic Art and Landscape Architecture, second year. Prerequisite, Fine Arts 451. Not open to Freshmen. Mr. Fanning.

From the beginning of the Renaissance in Italy to the beginning of modern tendencies in Art in the seventeenth century. Illustrated lectures, reading, and reports.

461. Modeling. (Five credit hours.) One Quarter. Autumn, Winter, Spring. Three three-hour laboratory periods each week, with weekly problems. Ceramic Art, third year. Prerequisite, Fine Arts 421. Mr. Frey.

This course includes the principles of cast making with practice.

462. Advanced Modeling. (Five credit hours.) One Quarter. Autumn, Winter, Spring. Three three-hour laboratory periods each week. Ceramic Art, third year. Prerequisite, Fine Arts 461. Mr. Frey.

465–466–467. Technical Problems. (Three to five credit hours.) Autumn, Winter,

Spring Quarters. Ceramic Art, third year. Landscape Architecture, fourth year. Mr. Hopkins, Mr. Baggs, Mr. Fanning, Miss DeBra, Mr. Frey, Miss Lazenby.

This course is open, by permission of the department, to students who show particular ability in design, drawing, painting, or sculpture, and who, having completed the other technical courses offered in the department, wish to pursue advanced problems in these fields under the supervision of the department. Students majoring in Landscape Architecture take special problems in planting design under these courses.

480. Ceramic Products. (Five credit hours.) Autumn Quarter. Ceramic Art, third year. Prerequisites, Fine Arts 431 and Ceramic Engineering 405. Mr. Baggs.

A study of products of clay, glass, and glass enamel, stressing design, finish, and quality in relation to service specifications. Industrial processes are described with special reference to methods and equipment of the artist.

481. Ceramic Composition and Decorative Processes. (Five credit hours.) Winter Quarter. Lectures and laboratory. Ceramic Art, third year. Prerequisite, Fine Arts 480. Mr. Baggs.

A review of the material mixtures and of the decorative processes employed and a historical classification of ceramic design.

482. Ceramic Shape Designing. (Five credit hours.) Spring Quarter. Ceramic Art, third year. Prerequisite, Fine Arts 481. Mr. Baggs.

A laboratory course in modeling, making of molds, and production of ware to acquaint students with the essential principles.

483. Ceramic Decorating. (Five credit hours.) Spring Quarter. Ceramic Art, third year. Prerequisite, Fine Arts 482. Mr. Baggs.

A laboratory course in designing and decorating clay wares by incising and relief treatment, slip painting, and pate-sur-pate.

484. Ceramic Decorating. (Five credit hours.) Autumn Quarter. Ceramic Art, fourth year. Prerequisite, Fine Arts 483. Mr. Baggs.

A laboratory course in color decoration by slips, vapors, salts, and glazes; on bisque, underglaze and overglaze; with hand and air brushes; by transfers, and templates; with lusters, etching, etc., on clay and glass.

485. Ceramic Decorating. (Five credit hours.) Winter Quarter. Ceramic Art, fourth year. Prerequisite, Fine Arts 484. Mr. Baggs.

A laboratory course in polychrome decorative designs applied by transfer from stone and steel, also architectural floor and wall polychrome designs.

486. Ceramic Ensemble Designing. (Five credit hours.) Spring Quarter. Ceramic Art, fourth year. Prerequisite, Fine Arts 485. Mr. Baggs.

A laboratory course in the designing of shapes, and the decoration of sets of tiles and art ware for exterior panel decorations and interior furnishing.

657–658–659. Proseminary. (Five credit hours.) Autumn, Winter, Spring Quarters. Ceramic Art, fourth year. Prerequisites, Fine Arts 451, 452, 453. Mr. Fanning.

Specialized study in important European Art periods. Ancient art subjects in Autumn; medieval in Winter; Renaissance and modern in Spring. Lectures, round-table discussions, and presentation by each student of some special phase of research.

661–662–663. Advanced Technical Problems. (Three to five credit hours.) Autumn, Winter, Spring Quarters. Ceramic Art and Landscape Architecture, fourth year. Mr. Hopkins, Mr. Baggs, Mr. Fanning, Mr. Frey, Mr. Church.

This course is open, by permission of the department, to students who have shown particular ability in design drawing, painting, or sculpture and who wish to pursue advanced problems in these fields under the supervision of the department. Students in Landscape Architecture pursue special work in design and construction under these courses.

Ceramic Engineering

401. Occurrence and Properties of Clays. (Four credit hours.) Winter Quarter. Four lectures and eight hours of preparation each week. Ceramic Art, first year. Mr. Watts.

The origin, occurrence, and distribution of clays and other ceramic materials, their physical properties, and the systems of measuring same.

405. Winning, Preparation, and Forming. Four credit hours. Spring Quarter. Four lectures and eight hours of preparation each week. Ceramic Art, second year. Mr. Carruthers.

The winning and preparation of ceramic materials and the forming of ceramic wares.

605. Bodies, Glazes, and Colors. (Four credit hours.) Winter Quarter. Four lectures and eight hours of preparation each week. Ceramic Art, second year. Prerequisites, Ceramic Engineering 401 and 615. Mr. Watts.

Ceramic bodies, glazes, and colors.

Chemistry

401. Elementary Chemistry. (Five credit hours.) One Quarter. Autumn and Winter. One lecture, one recitation, and two three-hour laboratory periods each week. For students who do not present chemistry as an entrance credit. Mr. Evans, Mr. Looker, and department assistants.

A general course in the chemistry of the nonmetals. It should be followed by Chemistry 402.

402. Elementary Chemistry. (Five credit hours.) One Quarter. Winter and Spring. One lecture, one recitation, and two three-hour laboratory periods each week. For students who do not present chemistry as an entrance credit. Prerequisite, Chemistry 401. Mr. Evans, Mr. Looker, and department assistants.

This course is a continuation of the study of the nonmetals and a survey of the chemistry of the metals. It should be followed by Chemistry 403.

403. Qualitative Analysis. (Five credit hours.) Spring Quarter. One lecture, one recitation, and two three-hour laboratory periods each week. For students who do not present chemistry as an entrance credit. Prerequisite, Chemistry 402. Mr. Evans, Mr. Looker, and department assistants.

A brief course in the systematic detection and separation of the metals and acids.

411. General Chemistry. (Five credit hours.) One Quarter. Autumn and Winter. One lecture, one recitation, and two three-hour laboratory periods each week. Prerequisite, an acceptable course in high-school chemistry. Mr. Evans, Mr. Day, and department assistants.

A general course in the chemistry of the nonmetals, more advanced than Chemistry 401. It should be followed by Chemistry 412.

412. General Chemistry. (Five credit hours.) One Quarter. Winter and Spring. One lecture, one recitation, and two three-hour laboratory periods each week. Prerequisite, Chemistry 411. Mr. Evans, Mr. Day, and department assistants.

This course is a continuation of Chemistry 411, and includes the chemistry of the metals. It should be followed by Chemistry 413.

413. Qualitative Analysis. (Five credit hours.) Spring Quarter. One lecture, one recitation, and two three-hour laboratory periods each week. Prerequisite, Chemistry 412. Mr. Evans, Mr. Day, and department assistants.

A general course in qualitative analysis, dealing with the systematic separation and identification of the metals and acids. It also includes the application of the ionization theory, mass action law, and the principles of chemical equilibrium to qualitative analysis.

Engineering Drawing

401. Principles of Engineering Drawing. (Four credit hours.) One Quarter. Autumn and Winter. One lecture and four two-hour laboratory periods each week. Ceramic Art, first year. All instructors.

Orthographic projection, auxiliary projection, sections, applied geometry, lettering.

402. Principles of Engineering Drawing. (Four credit hours.) Winter Quarter. One lecture and four two-hour laboratory periods each week. Ceramic Art, first year. Prerequisite, Engineering Drawing 401. All instructors.

Intersections, developments, working drawings, isometric and other pictorial representation, lettering.

Mathematics

431. Plane Trigonometry. (Five credit hours.) One Quarter. Autumn and Winter. Five recitations each week. Prerequisites, one and one-half units of entrance algebra and one unit of entrance geometry or Mathematics 400 and one unit of entrance geometry. All instructors.

DEPARTMENT OF FINE ARTS

The Department of Fine Arts is administered by the College of Education, but is by no means limited in the scope of its instruction to that one College. Students from the Colleges of Liberal Arts, Agriculture, Engineering, Commerce and Administration, etc., take the various courses offered in Art. Students in the College of Liberal Arts may major in this Department. The curriculum in Architecture, while administered by the College of Engineering, has part of its courses in the Department of Fine Arts.

The student registers in the College which offers the curriculum he wishes to follow.

The seminar room is equipped with a collection of over ten thousand photographs and about eight thousand lantern slides, carefully chosen illustrations of the finest artistic efforts of the ages. This collection is being added to each year by a studied selection from offerings of publishers, and from photographs made by staff members at home and abroad. The collection is open to the use of students, as are the art magazines and special reference works conveniently assembled in the seminar room as the work of the period demands.

The General Library of the University includes among its 300,000 volumes, a well selected collection of books and folios relating particularly to Fine Arts subjects. This growing collection is kept upon open shelves in a separate room in the Main Library, readily accessible to students of the Fine Arts.

The Department of Fine Arts has as its aim the instruction of students in the fundamentals upon which the creation of the visual arts depends, and the development of technical skill such as will enable the student to express beauty in form, color, and textures provided by the materials of the utilitarian arts. To accomplish these aims, the Department collaborates with other departments of the University and offers the curricula which are described on the preceding pages and which lead to the following degrees:

College of Liberal Arts: Bachelor of Arts with a major in Painting, Sculpture, Design, or History and Interpretation of the Fine Arts.

College of Education: Bachelor of Science in Education; Bachelor of Landscape Architecture; or Bachelor of Ceramic Arts.

Advanced courses in various art subjects are offered by the Department of Fine Arts to those able to pursue them. If such courses are taken with the expectation of receiving credit for them to apply toward any higher degree, the student must register in the Graduate School, under whose jurisdiction all work for the higher degrees is conducted. Every effort is made to promote the individual training of graduate students along the lines of their special interests and creative ability. Private studios, special equipment and models, as well as scholarships, have been secured where the special talents and ability of the advanced student seem to justify further work in advanced technical problems or research. For further information consult the Bulletin of the Graduate School.

Method of Admission

The admission of students to the University is in charge of the Entrance Board, which determines the credits that shall be issued on all entrance examinations and certificates, and furnishes all desired information to applicants. Correspondence relating to admission should be addressed to the University Examiner, Ohio State University, Columbus.

Admission to Courses Leading to a Degree

For complete entrance credit, an applicant for admission must be a graduate of a high school of the first grade or obtain credit by examination for fifteen entrance units.

For admission by examination or by certificate see the Bulletin of General Information.

(1) Distribution of Units

As a basis for the most advantageous arrangement of a college course, applicants are advised to present the following units for admission: three in English; one in American history and civics; one in algebra; one in geometry; one in physics or chemistry; one in botany, zoölogy, or physiology; three in one foreign language; and four as choice may direct. If this work is not presented for entrance, the student's progress may be retarded, as he will be required to carry courses in the University to make up the deficiency and he may not be able to obtain a degree in the usual four years.

(2) Entrance Conditions in Algebra and Geometry

A student who does not present for entrance one unit of algebra (through quadratics) and one unit of plane geometry will be admitted with conditions. Deficiencies in these subjects must be made up outside of university classes and the student must pass entrance examinations in them before entering upon his second year of residence.

(3) Special Students of Mature Years

A person of mature years who is unable to meet the entrance requirements in all respects, under certain circumstances, may be permitted to matriculate for specified courses for which he can demonstrate adequate qualifications. An applicant under twenty-one years of age will not be considered. Inquiry concerning such admission should be addressed to the Entrance Board, and to receive consideration must reach the Board not less than ten days in advance of the opening of the Quarter.

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ARTHUR BAGGS, *Professor of Fine Arts* (*Ceramic Art*).
RALPH FANNING, B. Arch., M.S., M. Arch., *Professor of Fine Arts* (*History of the Fine Arts*).
LESLIE LYNCH, B.S., M.L.A., *Professor of Fine Arts* (*Landscape Architecture*).
ALICE ROBINSON, B.S., *Assistant Professor of Fine Arts.*
ELUSINA LAZENBY, A.B., M.A., *Instructor in Fine Arts* (*Landscape Architecture*).
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GUY BROWN WISER, B. Arch., *Instructor in Fine Arts (Drawing).*
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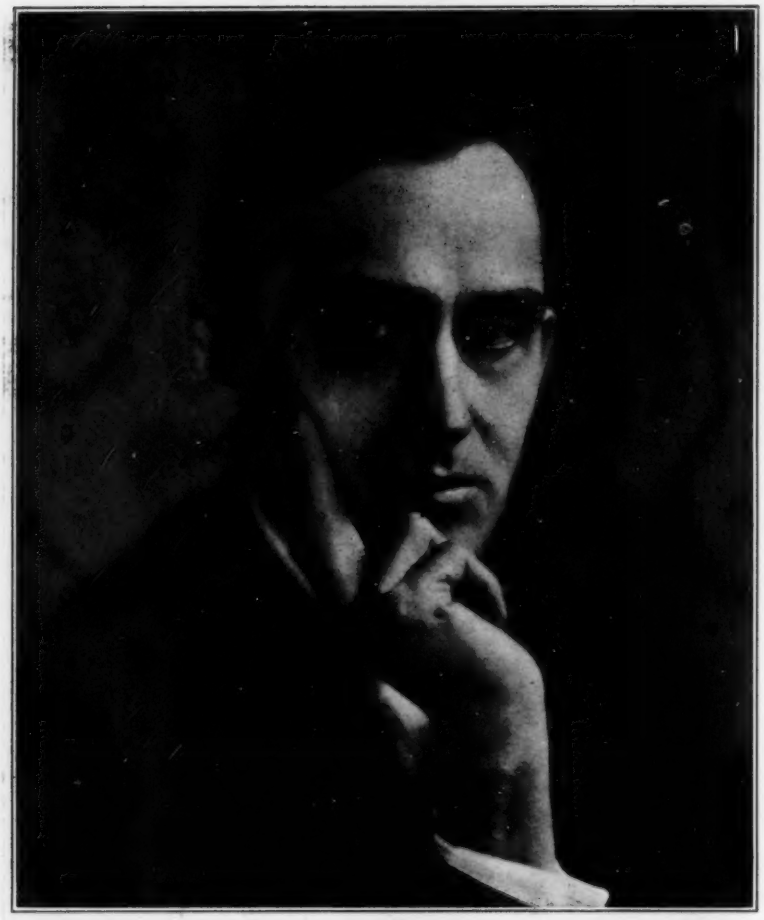
MABEL M. DEBRA, B.A., B.Sc. in Edu., M.A., *Instructor in Fine Arts (Design and Water Color).*
THOMAS CHURCH, B.S., M.L.A., *Instructor in Fine Arts (Landscape Architecture).*
ELIZABETH WALKER, B.Sc. in Edu., *Instructor in Fine Arts (Design).*
HOYT L. SHERMAN, *Assistant in Fine Arts.*
PAULINE EGBERT, *Secretary of Department Office.*

James R. Hopkins

Artist; b. Irwin, O. May 17, 1877; ed. Art Acad. of Cincinnati; spent 1 yr. in Paris, then traveled around the world, studying art in Japan, China, Ceylon, Egypt, Italy, etc. Painted in Paris 10 yrs., 1904–14; mem. faculty drawing and painting, Art Acad. of Cincinnati 1914–19; now prof. of Fine Arts, Ohio State U. Portrait and figure painter; awards: Walter Lippincott prize, Pa. Acad. Fine Arts, 1908; bronze medal, Buenos Aires Internat. Expn., 1910; gold medal, San Francisco Expn. 1915; Norman Wait Harris bronze medal, Art Inst., Chicago, 1916; Thomas Clark prize, Nat. Acad. Design, 1920. Represented in Cincinnati Mus. Assn., Atlanta Art Assn., Art Inst., Chicago. A.N.A. Assoc. mem. Société Nationale des Beaux Arts, Paris.



Arthur E. Baggs

B. Oct. 27, 1886, Alfred, N. Y.; ed. Alfred High School, 1903; N. Y. State College of Ceramics, Alfred, N. Y., 1903–1905, 1909–11; Art Students' League, N. Y. City; Lecture Course in Design, under Dr. Denman Ross, Harvard Univ.; Museum Study, New York; Museum of Fine Arts, Boston, Mass. Professional work: Director of pottery dept. at The Handcraft Shops, Marblehead, Mass., 1905–1908; director of the Marblehead Potteries, 1908–1915; owner and director of the Marblehead Potteries, 1915—; part time instructor in ceramics, Ethical Culture School, N. Y. City, 1913–20; part time instructor in ceramics, School of Design and Liberal Arts, N. Y. City, 1918–20; Associate ceramist with R. Guy Cowan, Cowan Pottery Studio, Rocky River, Ohio, 1925–28; Master in Ceramics, (part time) Cleveland School of Art, 1927–28; Professor Ceramic Art, Ohio State Univ. 1928—Member of AMERICAN CERAMIC SOCIETY, (Secretary, Art Division, 1925); Society of Arts and Crafts, Boston (Master Craftsman, medalist, 1925; served on governing council and as member of Craftsman Advisory Board); National Society of Craftsmen, N. Y. City; New York Society of Craftsmen; New York Society of Ceramic Arts; Detroit Society of Arts and Crafts; Artists' Guild of Chicago; Cleveland Museum of Art; Cleveland Society of Artists; Marblehead Arts Assn. *Honors:* Honorable Mention, Boston Society of Arts and Crafts, Special exhibition, Copley Hall, Boston, 1907; Mrs. J. Ogden Armour Prize for Pottery, Chicago Art Insti-

tute, 1915; Boston Arts and Crafts Society Medal, 1925; Charles F. Binns Medal, 1928; First prize, pottery, Cleveland Museum of Art, Annual Exhibition of work by Cleveland artists and craftsmen, 1928; represented by examples of pottery in permanent collections of Metropolitan Museum, N. Y., Museum of Fine Arts, Boston, Mass.; Newark Art Museum, A. and C. Society Medal; other public and private collections.

Ralph Fanning

Prof. fine arts; b. Riverhead, L. I., N. Y., Nov. 29, 1889; grad. Friends Acad., Locust Valley, L. I., 1908; B. Arch., Cornell U., 1912, M.S. in History, U. of Ill., 1917, M. Arch., 1920. Assoc. in architecture, U. of Ill., 1920, asst. prof. fine arts, Ohio State U., 1921–25; prof. fine arts since 1925; lecturer history of fine arts, U. of Calif., summers 1924–25. Mem. staff Emergency Housing Bd., U. S. Ship Building Corpn., 1917; emergency housing staff, Am. Red Cross, in France, 1918; housing staff, Friends Reconstruction Unit for devastated regions of France, 1918–19. Exhibitor water color painting, Pa. Acad. Fine Arts, 1924–25; Internat. Exhbn. water color painters, Chicago, 1924. Awarded Medal, Beaux Arts Soc., New York, 1912; Francis Sampson prize, 1912; Robert Wolfe water color prize, 1924.

Erwin F. Frey

Born Lima, O., April 21, 1892. Pupil of C. J. Barnhorn, James Fraser, Henri Bouchard, Paul Laudowski. Member: N.S.S. Award: Honorable Mention, Paris Salon, 1923. Work: Beatty Memorial, Springfield, O., assistant to Herbert Adams and Mrs. Louis Saint Gaudens, Cornish, N. H. Worked on the sculpture at Panama Pacific Exposition, San Francisco, 1915, under A. Sterling Calder, one year; assistant medalist at U. S. Mint, Philadelphia, in 1920. Honorable Mention, Paris Salon, 1923. Honorable Mention, Chicago Art Institute. Member National Sculpture Society. Two years instructor of sculpture, Columbus Art School. Two years Beaux Arts School of Design, sculpture class, New York; three years Cincinnati Art Academy under Barnhorn & Meakin; one year Art Students League under J. E. Fraser, N. Y. City; two years at Julien Academy, sculpture class, under Bouchard and Laudowski.

AN INTERNATIONAL EXHIBITION OF CERAMIC ART

In extension of its interests in contemporary industrial arts and decoration, the Museum will show in October the International Exhibition of Ceramic Art, now being assembled by The American Federation of Arts. A circuit of eight museums has been arranged including, after a first showing at the Metropolitan Museum, the following: The Baltimore Museum of Art, Carnegie Institute, The Cleveland Museum of Art, The Detroit Institute of Arts, The Minneapolis Institute of Arts, The Newark Museum Association, The Pennsylvania Museum and School of Industrial Arts.

This enterprise is made possible through a generous grant from the General Education Board. The Director of the Industrial Arts Division of this important body, Charles R. Richards, has been for many years a student and connoisseur of ceramics and by his friendly interest the present undertaking received great encouragement. The grant to the Federation covers a period of three years and makes possible a series of industrial art exhibitions, each a one-material or one-type exhibition, and all international in scope. Miss Helen Plumb has just returned from Europe where she has been collecting the material for the exhibit.

It is estimated that the forthcoming ceramic exhibition will contain from three to five hundred pieces of pottery and porcelain, with ample representation of English, French, German, Austrian, Dutch, Danish, Belgian, and Czechoslovakian, as well as American work.

Invitations have been sent to the American artists listed below: Leon Solon, Arthur Baggs, Chas. F. Binns, Alexander Blazys, Byrdcliffe Pottery, Guy R. Cowan, Russell G. Crook, E. de F. Curtis, Dover Pottery, Enfield Pottery & Tile Works, Marion L. Fosdick, Geo. F. Frederick, Paul Freigang, Mrs. Myrtle Meritt French, Fulper Pottery, Juanita Gonzalez, Jessie F. Gordon, Inwood Pottery, Frank B. Kelley, Henry C. Mercer, Julius Mihalik, Mrs. Bentley Nicholson, Mrs. Dorothea Warrn O'Hara, Pewabic Pottery, Mrs. Clara L. Poillon, H. Varnum Poor, Mrs. A. A. Robineau, Rookwood Pottery, Mary G. Sheerer, Wm. Soini, Jessie H. Stagg, Mrs. Geo. Oakley Totten, Chas. B. Upjohn, Leon Volkmar, Carl Walters, Zulma Steele, and Maude Robinson.

It is not known yet whether all these artists will be able to participate, especially in view of the fact that material which has been shown previously cannot be included in this exhibition.

THE MARKING OF IMPORTED POTTERY

On July 13 His Majesty approved three Orders in Council relating to the Merchandise Marks Act, 1926, and one, officially known as "Merchandise Marks (Imported Goods) No. 2 Order, 1928," makes it compulsory to mark with an indication of the country of origin certain types of pottery imported into the United Kingdom on and from Jan. 13, 1929.

The pottery to be marked is defined as follows:

(1) Articles of china or translucent pottery (including pottery known as china or porcelain), general earthenware or semiporcelain (excluding terra cotta ware, stoneware, and red and brown pottery), jet, rockingham or samian—
  (*a*) articles commonly used in connection with the serving of food or drink;
  (*b*) kitchen ware and utensils;
  (*c*) bedroom and other toilet ware;

(*d*) heraldic and souvenir ware including ware bearing any heraldic or similar device or any motto, monogram, or picture of a place in the United Kingdom or any phrase in the English language.

(2) (*a*) Floor tiles for tesselated pavements;
(*b*) glazed wall and hearth tiles.

(3) (*a*) Sanitary earthenware, white or cane and white;
(*b*) enamelled sanitary ware of fire clay;
(*c*) other sanitary ware (not including drain pipes).

There are exemptions to the above, for it is stated that the Order shall extend to any article (not being heraldic or souvenir ware) which is (*a*) an object of art, whether antique or not, wholly or mainly for ornamental use; (*b*) a toy; (*c*) a subsidiary part of a composite article in which the pottery is united with other material; (*d*) pottery for mounting, *i.e.*, pottery made for the purpose of being united with other material so as to form a composite article.

The Order states that not only shall the ware be marked when exposed for sale, but that it shall bear the mark at the time of importation. The indication of the origin shall be stamped, printed, embossed, or impressed on each article indelibly, but a lid or cover is exempted if the container itself is already marked.

As stated, the Order comes into force Jan. 13, 1929, six months after the day on which it was approved in Council; pottery imported during the six months' grace is not affected by the Order, *i.e.*, pottery imported between now and Jan. 13, 1929, need not necessarily be marked with the country of origin, unless, of course, the Merchandise Marks Act itself is violated by any suggestion that the ware is British. But dealers should carefully note that the ware to which the Order applies cannot be sold unmarked on and from Jan. 13 next year.

(*Pottery Gazette*)

CALENDAR OF CONVENTIONS

American Assn. for Advancement of Science	Dec. 27–Jan. 2, 1929	New York City
AMERICAN CERAMIC SOCIETY		
(Annual Meeting)	Feb. 4–9, 1929	Chicago, Ill.
American Chemical Society	Sept. 10–15	Swampscott, Mass.
American Concrete Institute		
(Annual Meeting)	Feb. 12–14, 1929	Detroit, Mich.
American Electrochemical Soc.		
(Fall Meeting)	Sept. 20–22	Charleston-Huntington, W. Va.
American Gas Assn.		
(Annual Meeting)	Oct. 8–12	Atlantic City, N. J.
American Soc. of Mechanical Engrs.		
(Regional)	Oct. 1–3	Boston, Mass.
(Annual Meeting)	Dec. 3–7	New York City
(Second Natl. Fuels Meeting)	Sept. 17–20	Cleveland, Ohio
American Soc. for Steel Treating		
(Annual Meeting)	Oct. 8–12	Philadelphia, Pa.
(Semi-Annual)	Jan. 14–18, 1929	Los Angeles, Cal.

American Zinc Institute	April 15–17, 1929	St. Louis, Mo.
Assn. of Scientific Apparatus Makers of America	May 3, 1929	Atlantic City, N. J.
German Glass Technology Meeting	Nov. 15–16	Berlin, Germany
The Mining Congress	Sept. 10–13	Los Angeles, Cal.
National Assn. of Manufacturers	Oct. 22–25	New York City
Natl. Assn. of Mfgrs. of Heating and Cooking Appliances	May 8–9, 1929	New York City
Natl. Exposition of Power & Mechanical Engrs.	December 3–8	New York City
Natl. Glass Distributors Assn.	Dec. 4–5	Pittsburgh, Pa.
Optical Society of America	Nov. 1–3	Washington, D. C
Safety Congress	Oct. 1–5	New York City
Taylor Society	Dec. 5–8	New York City

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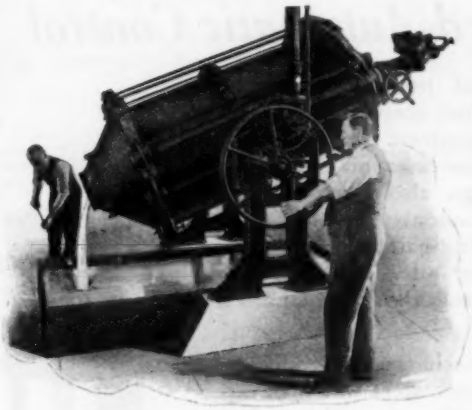

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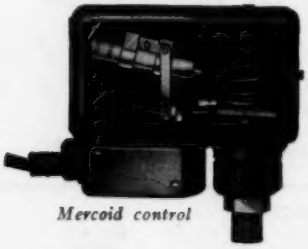

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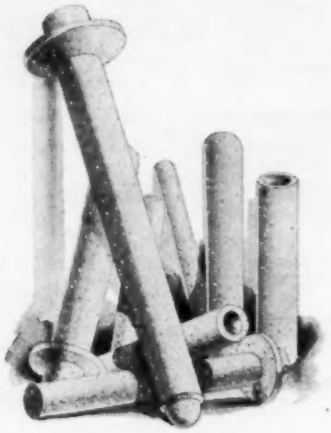

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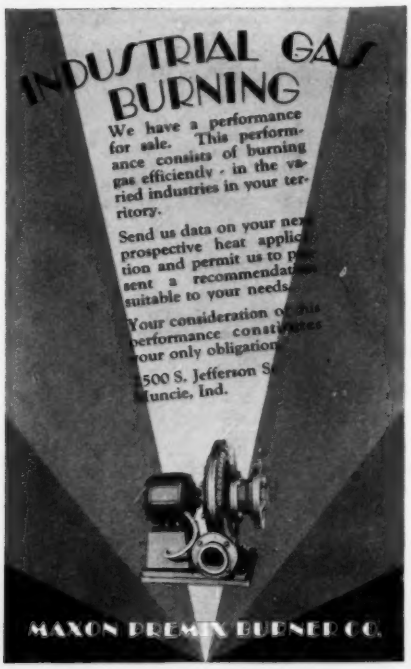
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	Page
American Gas Association	Inside Back Cover
American Potash and Chemical Corp.	18
American Rolling Mill Co.	2
Carborundum Co.	4-5
Chambers Brothers Co.	32
Chicago Vitreous Enamel Products Co.	33
Classified Advertising	30
Corundite Refractories, Inc.	26
Drakenfeld and Co., B. F., Inc.	22
Edgar Brothers Co.	20
Engelhard, Chas., Inc.	12
Erwin Feldspar Co.	36
Eureka Flint & Spar Co.	32
Exolon Company	24
Ferro Enamel Supply Co.	18
Fisher Governor Co.	3
Fisher Scientific Co.	35
General Electric Co.	34
Genesee Feldspar Co.	33
Golding Sons Co.	36
Harbison-Walker Refractories Co.	24
Harshaw, Fuller and Goodwin Co.	8
Innis, Speiden & Co., Inc.	26
Journal of the Society of Glass Technology	36
Kentucky-Tennessee Clay Co.	37
LaMotte Chemical Products Co.	33
Leeds and Northrup Co.	1
Maxon Premix Burner Co.	26
McDanel Refractory Porcelain Co.	28
Metal & Thermit Corp.	Outside Back Cover
Montgomery Porcelain Products Co.	32
Mueller Machine Co.	37
National Silica Co.	16
Norton Co.	14
Old Hickory Clay & Talc Co.	33
Pacific Coast Borax Co.	24
Pennsylvania Pulverizing Co.	34
Pennsylvania Salt Mfg. Co.	18
Philadelphia Drying Machinery Co.	38
Potters Supply Company	16
Proctor and Schwartz, Inc.	31
Professional Directory	36
River Feldspar Co.	18
Roessler and Hasslacher Chemical Co.	Inside Front Cover
Spinks, H. C. Clay Co.	28
Titanium Alloy Mfg. Co.	Center of Book 10
Tyler, W. S., Co.	Center of Book 9
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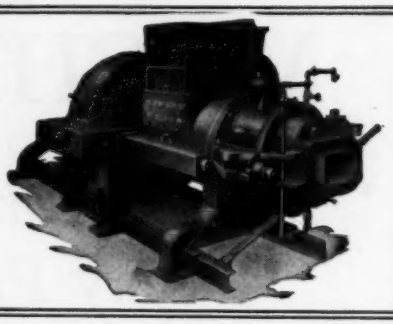

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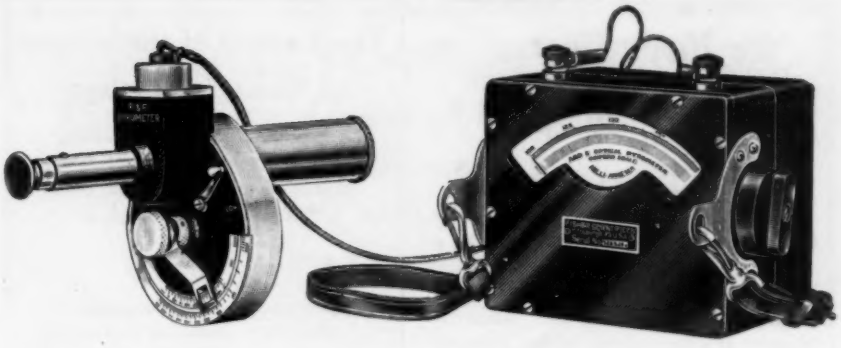

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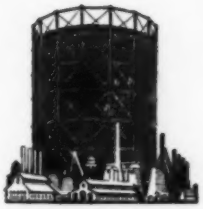

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